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Original article

The utility of a phase angle analysis in patients with severe motor and intellectual disabilities

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Abstract

Purpose: The purpose of the present study was to evaluate whether evaluating the phase angle (PhA), in a bioelectrical impedance analysis (BIA) is useful for estimating the nutritional status of severe motor and intellectual disabilities (SMID) patients.

Subjects and methods: This retrospective study included 31 SMID patients (mean age: 33.9 ± 13.5 years, median age: 29 years (range: 18–58 years), male/female: 23/8). First, each of the parameters from the total study population and the male and female SMID patients were compared with those of healthy Asian subjects. Second, correlation analyses were conducted to investigate the correlation between the PhA and the other BIA parameters (appendicular skeletal muscle mass index (ASMI), appendicular muscle mass (AMM), extracellular water (ECW)/total body water (TBW)) as well as subjective global assessment and serum nutritional markers. Finally, all patients were divided into 2 groups according to their albumin (Alb) (<3.5 or ≥3.5) values and PhA of the 2 groups were compared.

Results: The mean PhA and ASMI were a considerably low, whereas ECW/TBW was considerably high in comparison to the healthy Asian subjects. Significant negative correlations were observed between the PhA and ECW/TBW, whereas there were significant positive correlations between PhA and AMM, ASMI, total protein and albumin levels. Furthermore, PhA of Alb ≥3.5 group was significantly higher than that of Alb <3.5 group.

Conclusions: The present study indicated that SMID patients demonstrate the low PhA, which were similar to sarcopenia and a certain proportion of them also potentially have nutritional disturbances.

Keywords: Phase angle; Severe motor and intellectual disabilities; Bioelectrical impedance analysis

1. Introduction

Several body composition analyzing modalities are applied to evaluating the body compartments in the clinical setting. These include dual energy X-ray absorptiometry (DEXA), magnetic resonance imaging, and

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computed tomography. However, they have not been accepted as mainstream techniques due to their cost or the necessity of radiation exposure. Recently, bioelectrical impedance analyses (BIAs) has been used as an alternative, noninvasive method of analyzing the body composition. BIAs are now used in daily nutritional assessments [1,2]. BIA principally allows for the estimation of the components of the body structure by measuring the biological impedance against a subtle alternating current. A multi-frequency BIA can measure the total body water (TBW), intracellular water (ICW) and extracellular water (ECW) by applying the frequency-based difference of the transit current. The ECW/TBW has been the standard parameter for evaluating the body water balance and has also been reported as a useful parameter both for determining the nutritional status and for predicting the life prognosis in the critically ill patients [3]. Furthermore, the skeletal muscle mass, which is an important factor for diagnosing sarcopenia [4], can be calculated based on the TBW value.

The Phase angle (PhA) is the BIA parameter that is most frequently applied in the clinical setting. It reflects both the amount and the quality of soft tissue, and is currently regarded as a composite measure of tissue resistance and reactance [5]. The PhA increases according to the structural completeness of the cell membrane and the improvement of the cellular function, and decreases when plasma luminal structural damage of the cell is present. It also causes a decrease in the selective transmission function [5]. In a pure cell membrane mass, the PhA is 90 degrees, while that in pure electrolyte water is 0 degrees. In healthy subjects, the PhA typically range from 8° to 15° [6]. Thus, the PhA is suggested to be a good indicator of cellular health and a high PhA value reflects the high cellularity and the integrity and the function of the cell membrane [6]. Moreover, this parameter has also been used as a nutritional indicator that correlated with the nutritional parameters such as serum transthyretin (TTR) and has gained popularity because it has been shown to be highly predictive of an impaired clinical outcome and increased mortality in a variety of diseases [7].

In the pediatric field, the presence of severe motor and intellectual disabilities (SMID) has been recognized as a critical disorder that requires intensive nutritional support due to the presence of neurological and/or metabolic disorders, and because it is associated with a high incidence of complications such as gastroesophageal reflux disease and oropharyngeal discoordination. SMID patients frequently require surgical procedures such as anti-reflux surgery and tracheostomy and pediatric surgeons face various problems in their perioperative management, most notably, in managements associated with their insufficient nutrition at the referring institution.

Although it should be fundamental to accurately evaluate their nutritional status, it is often difficult to calculate it from physical measurements due to their severe scoliosis. Another nutritional assessment technique, which combines the evaluation of temporal weight changes and the hematological/nutritional index has often been attempted for SMID patients. However, such techniques may be less accurate because the height-for-age and weight-for-age growth standards of SMID patients are lower than those of the reference population and the TTR value is often affected by non-nutritional factors such as chronic inflammation. Thus, a nutritional assessment that utilizes the BIA might be well-suited to SMID patients. To the best of our knowledge, no previous reports have assessed the nutritional status of SMID patients by analyzing the PhA. However, several clinical reports regarding the application of the PhA to the assessment of the nutritional status of other subjects have been found [1,2,7,8].

The purpose of the present study was to evaluate whether the PhA is a useful parameter for estimating the nutritional status of SMID patients. We investigated the relationship between the PhA and other BIA parameters, the subjective global assessment (SGA) parameters and serum nutritional markers levels.

2. Patients and methods

This present retrospective study included 31 SMID patients $\geq$18 years (male, $n = 23$; female, $n = 8$; mean age, 33.9 ± 13.5 years; median age: 29 years (range: 18 to 58 years)) who were admitted for surgical treatment in Kurume University Hospital between June 2013 and March 2016.

Regarding the causal disorders of SMID, one had a genetic anomaly, 1 had a chromosomal anomaly, 2 had congenital parencephalia, 2 had congenital cytomegalovirus infection, 13 had perinatal brain injury, 8 had acquired brain injury and 4 were unknown. Eleven patients had undergone respiratory tract surgical procedures (tracheostomy: 3, laryngotracheal separation: 7 and total laryngectomy: 1) and 16 had gastrostomy.

All of the patients were bedridden and 29 patients required tube feeding (nasogastric tube: 13 patients or gastrostomy tube: 16 patients). There were only 2 patients who were fed orally. The patients who were suffering from decompensated heart, lung, kidney or liver failure or the involuntary loss or gain of >5% body weight in the previous 3 months (which affected the BIA data) were excluded from the present study. Informed consent was obtained from the patient's families before they were enrolled in the present study. All of the patients underwent a baseline nutritional assessment, which included laboratory measurements of the SGA parameters, including their age, height, weight, body mass index (BMI) and the measurement of the

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