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Research paper

Bioelectrical impedance vector analysis as an auxiliary method in diagnosing of sarcopenia among hospitalized older patients – a preliminary report

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ABSTRACT

Background and purpose: The prevalence of sarcopenia varies depending on environments and populations of older people. What is more, in separate studies different diagnostic criteria are used. The aim of this study was to investigate the prevalence of sarcopenia in an examined sample of older patients and to verify whether bioelectrical impedance analysis (BIVA) may be used as an auxiliary method in diagnosing of sarcopenia among hospitalized older patients.
Materials and methods: The European Working Group of Sarcopenia in Older People (EWGSOP) algorithm using two different muscle mass criteria was applied and among misclassified subjects we used BIVA parameters to verify the prevalence of sarcopenia.
Results: The prevalence of sarcopenia ranged between 60.7% and 79.8% according to the two suggested different muscle mass cutpoints. Seventeen subjects mismatched according to used muscle mass cutpoints were further analyzed individually on the basis of their mean BIVA parameters. The location of the confidence ellipse of misclassified women overlapped with the women group diagnosed as "nonsarcopenic", while sarcopenic group was statistically different.
Conclusions: BIVA is a valuable tool that may be used as an auxiliary method to verify the prevalence of sarcopenia among older women. Mismatched women were characterized with BIVA parameters similar to that of nonsarcopenic women and clearly different from BIVA parameters of their sarcopenic peers. Due to the small number of nonsarcopenic men in our sample further studies are required to verify if this method may also be an additional assessment tool for men.

1. Introduction

Sarcopenia emerges as one of the most important health problems among the elderly. As many geriatric syndromes, it is characterized by multifactorial origins, mechanisms and symptoms that very often overlap with other conditions. It is, thus, still rarely recognized by physicians [1,2].

The prevalence of sarcopenia is different among various environments and populations. What is more, it differs in separate studies because of the numerous methods that were used to diagnose it [3]. Defining sarcopenia may be depended on the method used to assess the skeletal muscle mass [4].

The European Working Group of Sarcopenia in Older People (EWGSOP) recommends using the presence of both low muscle mass and low muscle function for the diagnosis of sarcopenia. Since April 2010, when the EWGSOP report was published [5], a general EWGSOP-suggested algorithm for the diagnosis of sarcopenia in older subjects was developed on the basis of consecutive studies.

According to the EWGSOP bioelectrical impedance analysis (BIA) is "a good portable alternative" to dual-energy X-ray absorptiometry (DXA) method for the assessment of muscle mass [5]. Bioelectrical impedance vector analysis (BIVA) is developed by Piccoli et al. [6] vectorial approach of BIA. This method relies on comparing bioelectrical parameters values normalized for height in order to eliminate conductor length effect. Available studies have confirmed the BIVA technique is promising tool for the screening and monitoring the nutritional status of patients in different conditions [7–9].

With the EWGSOP algorithm that allows to recognise sarcopenic patients, even with the same method used to examine

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muscle mass, different cut-off points for diagnosis the muscle mass decline may be taken. Therefore, the number of subjects presenting a decline of muscle mass may vary critically.

The aim of this study was to verify whether BIVA may be used as an auxiliary method in diagnosing of sarcopenia among hospitalized older patients. We compared the prevalence of sarcopenia in an examined sample according to the EWGSOP algorithm using two different muscle mass criteria and among misclassified subjects we used BIVA parameters to confirm or exclude the diagnosis of sarcopenia.

2. Materials and methods

2.1. Subjects

All the examined subjects were patients of the geriatric acute care ward in the centre hospitalier Lyon-Sud, France, admitted between May and July 2014. The study was approved by the local Bioethics Committee. The inclusion criteria were: age 60 years and over, verbal-logical contact (patients had to be able to understand the instructions), ability to walk, and expressed voluntary consent to participate in the study. Patients who were not able to stand, suffered from serious psycho-cognitive impairment, and in palliative situations were excluded from the study. Pacemaker users and patients with edema were also excluded because of requirements for bioelectrical impedance analysis (BIA) method.

Out of 180 patients admitted to the acute geriatric ward during the period of the study, 91 were excluded because of clinically visible edema, severe mental disorders, hospitalization for terminal disease, acute pneumonia, sepsis, acute fracture, implantable pacemaker, or because they were not able to rise from the chair or bed. Finally, 89 patients from the acute geriatric ward, 56 women and 33 men aged from 62 to 101 years (average 84.9 ± 6.61 years) have been included and have taken part in the study.

The patients were admitted to the acute geriatric ward due to many diverse medical causes. The participants suffered from different diseases: hypertension (59 participants), cardiovascular diseases (44 people), diabetes mellitus (24 patients), osteoarthritis (23 people), eye diseases (18 patients), osteoporosis (23 participants), depression (19 patients), neurological diseases (27 participants), and cancer (25 patients).

2.2. Methods

All patients studies were performed at the beginning of hospitalisation (within 24 hours of admission). The functional status assessment of each subject was carried out by the Activities of Daily Living (ADL) Scale [10]. To verify the prevalence of sarcopenia all the participants were examined according to the recommendations of EWGSOP [5]. The EWGSOP algorithm has been used.

2.3. Muscle mass

Patients' body mass was assessed in the morning, in light clothes using a chair scale (SOEHNLE type 7702, Germany) to the nearest 0.1 kg. The height of the patients was measured and the body mass index (BMI) was calculated as weight/height^2 and was given in kg/m^2. Bioelectrical impedance analysis resistance (R, Ohm) was used to estimate muscle mass and was obtained using the Quad Scan 4000 analyzer (Bodystat Ltd., United Kingdom). Whole body measurements were taken with subjects in a supine position on the right side of the body between the wrist and the ankle, on a non-conducting surface, with the subjects having completed a minimum 4-hour fast (in the morning, before breakfast) and according to recommendations from the manufacturer [11]. Muscle mass was calculated according to the formula of Janssen et al. [12] and the skeletal mass index (SMI) was also calculated [13].

SMI cut-off points were used according to Chien and Janssen suggestions. Chien's SMI cut-off points [14] were 8.87 kg/m^2 for men and 6.42 kg/m^2 for women while cutpoints suggested by Janssen et al. [13] were <10.76 for men and <6.76 kg/m^2 for women.

2.4. Muscle strength

A standardised protocol [15] was used to measure muscle strength with Jamar hydraulic hand dynamometer (model SH5001, SAEHAN, Korea). The test was repeated 6 times (3 trials with each hand with 15 second pauses between each trial). The best score of the dominant hand was used for analysis. The cutpoints applied were as follows: <30 kg for men and <20 kg for women [5,16]. Before the study, handgrip strength of 20 patients was examined twice to verify the correct functioning of the dynamometer and reproductibility of measures.

2.5. Physical performance

Every participant's gait speed was measured using 4-meter Walking Test as a speed over a 4-meters course at the usual pace and was given in meters per second (m/s). Timing began when participants initiated the foot movement and stopped when one foot contacted the ground after crossing the 4-meter distance. Every patient performed the test twice and the best result was used for analysis. The gait speed cut-off point of ≤0.8 m/s was applied for identifying the risk for sarcopenia [16,17].

2.6. BIVA

The individual components of the impedance vector, resistance (R, Ohm) and reactance (Xc, Ohm), normalized for subjects' height were plotted in the Cartesian plane defined by the R/H and Xc/H axes (R/Xc graph). Through BIVA confidence analysis we compared sarcopenic and nonsarcopenic groups defined by the mean impedance (Z, Ohm) vector normalized for height (Z/H). The confidence ellipses were calculated using BIVA free software [18].

3. Statistical analysis

Statistical analysis was performed using the statistical program Statistica 10th CSS. Data was verified for normality of distribution and equality of variances. The one-way analysis of variance (ANOVA) and Mann-Whitney test were used to compare the groups. The results of the quantitative variables are presented as mean ± SD (standard deviation). The mean impedance vectors of sarcopenic and nonsarcopenic groups were compared with the Hotteling T^2 test, which is a multivariate extension of the Student's test for unpaired data in comparison of two vectors in two groups, and Mahalanobis distance D was calculated. The limit of significance was set at $P \leq 0.05$ for all analyses.

4. Results

There was no significant difference between men and women concerning age, and BMI. Men in comparison with women were characterized by significantly higher SMI (8.64 kg/m^2 ± 0.96 kg/m^2 vs. 6.07 kg/m^2 ± 0.94 kg/m^2; $P < 0.0001$), right handgrip strength (20.94 kg ± 7.62 kg vs. 12.2 kg ± 4.45 kg; $P < 0.0001$), left handgrip strength (19.73 kg ± 7.66 kg vs. 11.4 kg ± 4.40; $P < 0.0001$) and gait speed (0.63 m/s ± 0.46 m/s vs. 0.40 m/s ± 0.22 m/s; $P = 0.0017$).