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Original Research

Ultrasound-Based Detection of Low Muscle Mass for Diagnosis of Sarcopenia in Older Adults

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Abstract

Objective: To establish muscle-specific cut-off values for ultrasound-based detection of low muscle mass, and to assess its prevalence in a population of frail older subjects when applying the cut-points of different muscles and those of different sarcopenic indices.
Design: Cross-sectional study.
Setting: Geriatric outpatient clinic and clinical research laboratory.
Methods: A total of 44 older adults (30 women and 14 men, mean age 82 years, range 67-93 years) and 60 younger individuals (30 women and 30 men, mean age 26 years, range 20-36 years) participated. Body composition and thickness of 4 lower limb muscles (rectus femoris, vastus lateralis, tibialis anterior, medial gastrocnemius) were respectively assessed by bioelectrical impedance analysis (BIA) and ultrasonography.
Main Outcome Measurements: Site-specific cut-points for ultrasound-based assessment of low muscle mass (muscle thickness values 2 standard deviations below the gender-specific means of our sample of younger subjects) and comparative prevalence rates of low muscle mass.
Results: The following site-specific cut-points for muscle thickness were identified: rectus femoris: 20 mm in men and 16 mm in women; vastus lateralis: 17 mm in men and 15 mm in women; tibialis anterior: 23 mm in men and 22 mm in women; and medial gastrocnemius: 13 mm in both men and women. The prevalence of low muscle mass in older adults was highly dependent on the muscle being investigated; it varied from 86% for thigh muscles to 30% for leg muscles. Moreover, the prevalence of low muscle mass was highly dependent on the applied diagnostic criterion and on the adopted cut-off value; it ranged from 2% to 75% for different BIA-derived criteria.
Conclusions: We suggest that muscle ultrasonography provides physiatrists with a practical and accurate tool for identifying individuals with low muscle mass. However, the usability of cut-off values established in our group of healthy younger subjects of white ethnicity to identify low muscle mass in older individuals of different ethnic groups remains to be demonstrated in future studies.

Introduction

Primary sarcopenia, the age-related loss of skeletal muscle mass and function [1,2], is associated with disability and frailty that represent major socioeconomic as well as medical problems. In rehabilitation patients, primary sarcopenia can be further exacerbated by the disuse- or drug-related loss of muscle mass or function. Therefore, elderly rehabilitation patients could benefit from the assessments of skeletal muscle mass and function for the detection of sarcopenia.

A major development in sarcopenia research has been the convergence in its operational definition. Several consensus groups have recently published operational criteria for the diagnosis of sarcopenia (incorporating the evaluation of muscle mass with the assessment of strength and/or physical performance), including the European Working Group on Sarcopenia in Older People (EGWSOP) [3], the International Working Group on Sarcopenia (IWGS) [4], and the "Foundation for the National Institutes of Health Sarcopenia Project" [5]. All 3 consensus groups included the appendicular skeletal muscle mass (ASMM) assessment, as performed with dual-energy x-ray absorptiometry (DXA), into the operational definition of sarcopenia. However, different indices of ASMM (such as ASMM normalized to height

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or to body mass index) and different cut-off points were considered. Other sarcopenic indices, which are commonly used in research as well as in clinical routine, are based on the assessment of the total body skeletal muscle mass (TSMM, normalized to body weight or to height), as carried out with bioelectrical impedance analysis (BIA) [6,7]. However, the use of different diagnostic criteria may lead to different conclusions, as evidenced by several investigations recently performed in community-dwelling older adults [8-15]. In addition, although the use of DXA- or BIA-derived sarcopenic indices may be practical for clinical purposes, they do not seem to be very accurate [1]. This is essentially due to the fact that sarcopenia is not a uniform condition as it affects postural muscles more than nonpostural ones [1,2,16-18]. Therefore, site-specific assessment of loss of muscle mass may be required for its early and accurate detection. Consistently, recent studies showed that thigh sarcopenia can be detected by ultrasound-based assessment of muscle thickness before it appears at the whole body level [19,20]. However, as highlighted by Abe et al [19], there are no published site-specific cut-points for ultrasonographic assessment of low muscle mass in older adults. Therefore, the aims of this study were as follows: to establish muscle-specific cut-off values for ultrasound-based detection of low muscle mass; to assess the prevalence of low muscle mass in a population of frail older subjects when applying the ultrasonographic cut-points of different lower limb muscles; and to assess the prevalence of low muscle mass when applying different sarcopenic indices derived from ultrasound, BIA, and anthropometry.

Methods

Study Subjects

A total of 44 older adults (30 women and 14 men, mean age ± SD: 82 ± 7 years; range 67-93 years; body mass index: 25 ± 5 kg/m^2) and 60 younger individuals (30 women and 30 men, age: 26 ± 3 years; range 20-36 years; body mass index: 22 ± 3 kg/m^2) volunteered to participate in the study (convenience sample). The younger subjects were habitually physically active, and none participated in competitive sports. The older group was composed of institution-dwelling individuals who met 1 or more of Fried's frailty criteria [21]. Side dominance was assessed with the Waterloo Handedness and Footedness Questionnaires—Revised [22]. One older subject and 6 younger subjects were left-side dominant. Each participant received a detailed explanation of the study and gave written informed consent before participation. The study conformed to the ethical principles enunciated in the Declaration of Helsinki and was approved by the local Ethics Committee.

Assessments

The following measurements were taken in younger subjects to obtain normative muscle mass data that could be used for establishing cut-off points (for the detection of low muscle mass): anthropometric measurements (height and weight), TSMM and ASMM using BIA, and thickness of 4 lower limb muscles using ultrasonography. The same measurements were also taken in older subjects while calf circumference, walking speed, and handgrip strength were also measured in this group.

Anthropometric Measurements

Measurements of height and weight were made in overnight fasted subjects (in light clothing and barefoot or with socks) on the same day as all the other tests. Standing height was measured to the nearest 0.5 cm using a wall-mounted stadiometer. Body weight was determined to the nearest 0.1 kg using a calibrated balance beam scale. Calf circumference (dominant side) was measured to the nearest 0.1 cm while the subjects were seated with their legs hanging loosely. The measurement tape was wrapped around the calf, and the highest value was retained. A cut-off point of <31 cm [23] was adopted to identify low muscle mass.

Physical Performance

Subjects were asked to walk over a 14-m walkway at a self-selected usual speed, and their walking speed was evaluated. A stopwatch was used to time the subjects as they walked over the central 10 m of the walkway. The initial 2 m and final 2 m were not considered, to allow for acceleration and anticipatory deceleration. The distance covered was divided by the time taken to complete the 10-m walk. Subjects completed 3 trials, and the mean walking speed of the 3 trials was retained. A cut-off point of <0.8 m/s [3] was adopted to identify subjects with low physical performance.

Muscle Strength

Handgrip strength was measured on the dominant side using a handheld device (Jamar Plus Digital Dynamometer, Patterson Medical, Warrenville, IL). The subjects were sitting comfortably with the shoulder adducted, the elbow flexed at 90°, and both the forearm and the wrist in a neutral position. They were instructed to perform a maximal voluntary isometric contraction by contracting their muscles as forcefully as possible for 4-5 seconds. The test was repeated 3 times with 30 seconds of recovery in between. If the peak forces of the 3 trials were within 5% of each other, the highest value was retained; otherwise, additional trials were performed until the 5% criterion was achieved. Cut-off points of <30 kg for men and <20 kg for women [3] were adopted to identify subjects with low handgrip strength.