



Validation of InBody 770 as a Tool for Assessing Skeletal Muscle Mass

Keisuke Oyama, Hisataka Ogawa*, Mao Osaki, Syugo Kono, Makoto Hasegawa, Yusuke Izutani, Kazuya Kato, Seiya Kurimasa, Himura Hoshi, Nobuyoshi Ohara, Yuichiro Miyake, Jota Mikami, Sakae Maeda, Shin Nakahira, Yoichi Makari, Ken Nakata, Junya Fujita and Hiroki Ohzato

Department of Surgery, Sakai City Medical Center, Japan

Abstract

Sarcopenia is defined as age-related muscle loss that contributes to weakening muscle strength and limited physical performance. It is also reported as an independent prognostic factor in patients with gastrointestinal tract cancer. Computed Tomography (CT) scan has been the gold standard for assessing skeletal muscle mass, despite its drawbacks, including the long-time required, high cost, and radiation exposure. The present study aimed to validate bioelectrical impedance analysis, with the InBody 770 tool, for assessing skeletal muscle mass. In our hospital, we have started sarcopenia screening using InBody 770 for patients with gastrointestinal cancer since 2018. A total of 112 consecutive patients that had undergone gastrointestinal tract cancer surgery, between May and Dec 2018, received preoperative skeletal muscle mass measurements with both CT scan and InBody 770. The correlation between Skeletal Muscle Mass Index (SMI) measured by InBody 770 and the psoas major muscle area index (L3 level) and the psoas major muscle volume index was investigated using image analysis software (SYNAPSE VINCENT). The SMI, psoas muscle area index, and psoas muscle volume index were: 6.3 ± 1.1 kg/m², 4.4 ± 1.4 cm²/m² and 90.3 ± 30 cm³/m². The SMI was correlated more strongly with the psoas muscle volume index ($r=0.62$) than with the psoas muscle area index ($r=0.58$). Our results demonstrated that the InBody 770 could act as a substitute for CT scan, in measuring skeletal muscle mass.

Introduction

In 1989, Rosenberg proposed that sarcopenia was “age-related muscle loss, accompanied by muscle weakness and physical function decline” [1]. The presence of sarcopenia was reported to affect the postoperative prognosis of survival after digestive tract surgery [2]. Recently, the prevalence of sarcopenia among patients with surgery has increased in this aging society [3]. Aged patients with cancer typically have sarcopenic phenotypes, due to malnutrition, cancer-induced cachexia, and reduced activity [4]. In 2014, the Asian Working Group of Sarcopenia (AWGS) reported that sarcopenia for Asians could be definitively diagnosed by observations of slower walking speed (less than 0.8 m/s), lower grip strength (males: less than 26 kg, females: less than 18 kg), and lower skeletal muscle mass, compared to standard values [5]. In this report, the AWGS addressed the available methods of measuring skeletal muscle mass in detail. Previously, CT scan has been used as the gold standard for evaluating body composition [6], in spite that some drawbacks have limited their applications, including the high cost, CT scan-generated radiation exposure, and their inconvenience in a community screening. In comparison, Bioelectric Impedance Analysis (BIA) may provide a good substitute for assessing body composition, due to its portability, short time requirement, and reasonable cost. Several kinds of BIA-based equipment have been developed to assess body composition [7-9]. However, the accuracy of BIA depends on the accuracy of the equipment and the assessment conditions. The actual Skeletal Muscle Mass Index (SMI) may value differs, depending on the equipment used. For these reasons, the AWGS recommended that, in diagnosing sarcopenia with BIA, we should provide a coefficient of variance and inter- and intra-examiner reliability [5]. InBody 770 (InBody Japan, Tokyo, Japan) is a relatively new analyzer. It has direct segmental multifrequency BIA system and simultaneous multi-frequency impedance measurement system. It is fast (scans in 1 minute), and it has fine-tuned processing. It performs a total of 30 impedances, measured at six different frequencies (1, 5, 50, 250, 500, 1000 kHz) in five body segments (right arm, left arm, trunk, and right leg, left leg). It also performs a total of 15 reactance measurements with tetrapolar, 8-point, tactile electrodes, measured at three different frequencies (5, 50, 250 kHz) in the five aforementioned body segments [10]. In the present study, we aimed to validate InBody 770 for assessing skeletal muscle mass, compared to a CT-based skeletal

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*Correspondence:

Hisataka Ogawa, Department of Surgery, Sakai City Medical Center, 593-8304, 1-1-1 Ebaraji-cho, Nishi-ku, Sakai City, Osaka, Japan, Tel: +81-72-272-1199; Fax: +81-72-272-9911; E-mail: darib09078783810@gmail.com

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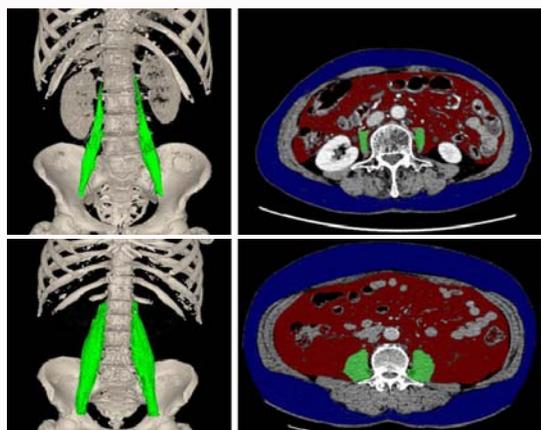


Figure 1: Psoas muscle volume and area assessed by Synapse Vincent. The green area shows the psoas muscle.

A: volume 73.29 cm³, area 4.37 cm², B: volume 454.75 cm³, area 26.07cm²

Table 1: Summary of patient characteristics.

Variables	N=112
Gender: Male:Female	66:46
Age: (y), mean (SD)	71.5 (9.5)
Cancer site:	
Esophagus	3 (2.7%)
Stomach	29 (25.9%)
Colorectal	38 (33.9%)
Liver	26 (23.2%)
Biliary tract	2 (1.8%)
Pancreas	11 (9.8%)
Others	3 (2.7%)
BMI (kg/m ²), mean (SD)	21.4 (3.6)
SMI (kg/m ²), mean (SD)	6.3 (1.1)
Psoas muscle area index (cm ² /m ²), mean (SD)	4.4 (1.4)
Psoas muscle volume index (cm ³ /m ²), mean (SD)	90.3 (30)

Values are the number (%) of patients, unless indicated otherwise

Abbreviations: BMI: Body Mass Index; SMI: Skeletal Mass Index

muscle mass evaluation, as reference.

Materials and Methods

From May to December 2018, we measured skeletal muscle mass with the InBody 770 in 112 patients that underwent Gastrointestinal (GI) cancer surgery and compared the results to a CT scan. InBody 770 automatically calculates SMI values based on measured impedance [5,11]. To maintain accuracy and reproducibility, we followed the manufacturer's instructions. Briefly, patients were removed from drip infusions, fasted for three hours, and instructed to urinate and excrete just before the measurement. For the CT scan measurements, we reviewed plain CT scans that patients routinely received for cancer diagnosis and TNM staging. In CT-based assessments, previous reports have shown that the psoas muscle area at the L3 vertebral body level was highly likely to represent the total skeletal muscle mass [12,13]. The psoas major muscle runs from the 12th thoracic vertebra to the 4th lumbar vertebra, and it adheres to the small femoral trochanter. This anatomical feature enables reproducibility. However, the psoas muscle area assessment at the L3 level can occasionally be inaccurate in selected patients with spine deformations, such as a turtleback or scoliosis. We employed a newly developed workstation called SYNAPSE VINCENT (Fujifilm Medical Co., Tokyo, Japan) (Figure 1) that has enabled significantly accurate measurement of

the actual psoas muscle volume [14,15]. Psoas muscle mass index was calculated by dividing the cross-sectional area of psoas muscle mass measured at the L3 level divided by the patient's height squared. Psoas muscle mass volume was calculated by dividing the actual psoas muscle mass volume divided by the patient's height squared in this study, we used both the psoas muscle area index and the psoas muscle volume index for CT-based skeletal muscle mass evaluations.

Results

This study included 112 consecutive patients (Table 1). The primary cancer lesion site varied. The mean BMI was 21.4 ± 3.6 kg/m². The SMI, psoas muscle area index, and psoas muscle volume index were: 6.3 ± 1.1 kg/m², 4.4 ± 1.4 cm²/m² and 90.3 ± 30 cm³/m², respectively. After confirming that the SMI, the psoas muscle area index, and the psoas muscle volume index data were normally distributed (data not shown), we employed the Pearson correlation coefficient method. Scatter plots of skeletal muscle mass showed a significant correlation between the values measured with InBody 770 and CT scan (Figure 2). Of note, the SMI showed a stronger correlation with the psoas muscle volume index (r=0.62) than with the psoas muscle area index (r=0.58) (Table 2). The SMI and BMI also showed a slightly strong correlation (r=0.57), but the SMI and age did not (r=-0.25).

Discussion

Sarcopenia has been proven to be a significant risk factor for postoperative outcomes [16]. Although the specific etiologies of cancer sarcopenia remain unclear, recent clinical research in the field of surgery emphasizes on preoperative nutritional and physical rehabilitation of patients with sarcopenia. This concept of "nutritional prehabilitation" is much-attracting attention because such kind of intervention is the only possible way for us clinicians against sarcopenia and the improvement of the patient condition can lead to rapid postoperative recovery and prolonged survival [17,18]. However, it is difficult to secure sufficient time for a presurgical intervention in a clinical setting. Postponing an operation and a lengthy intervention might allow deterioration, due to primary disease progression. Therefore, precise and fast assessment of skeletal muscle mass is necessary for the preoperative intervention. Our main findings in this study were: (1) SMI calculated by InBody 770 was strongly correlated with psoas muscle mass volume index (r=0.62) and area index at L3 level (r=0.58) (2) BMI was also strongly correlated with SMI (r=0.62), but age did a weak correlation (r=-0.25). Previous reports indicated that psoas muscle mass at L3 level is a useful tool to evaluate skeletal muscle mass in diagnosing sarcopenia [19,20]. Moreover, recent progress in imaging software enabled us to measure directly psoas muscle volume. In this study, our results validated InBody 770 as a useful tool in assessing skeletal muscle mass, which is consistent with the previous report [13,21]. In addition to that, InBody 770 has an advantage over CT scan in terms that InBody 770 can provide other useful parameters to assess body composition [21-24]. BMI was significantly correlated with the SMI, which was consistent with previous reports [25]. We also found that patient age was not correlated with the SMI, in contrast with results from previous reports [13,26,27]. This discrepancy might arise from the various etiologies of cancer. Patients with cancer are at increased risk of muscle loss, mainly via cachexia, defined as cytokine-mediated degradation of muscle and adipose depots [12,28]. Besides, patients with GI tract cancers tend to exhibit digestive symptoms, such as nausea, abdominal pain, and diarrhea, which lead to reduced

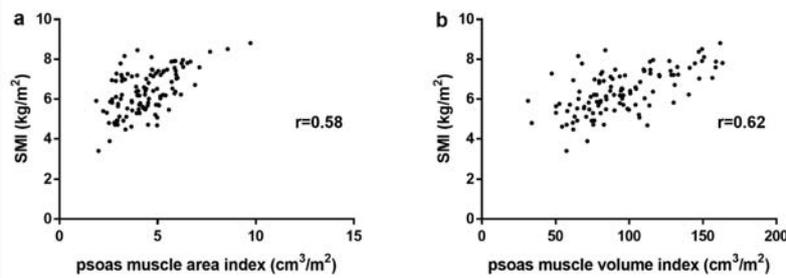


Figure 2: Correlations between the Skeletal Muscle Mass Index (SMI) and the psoas muscle area index (a) or the psoas muscle volume index (b).

Table 2: Correlation with SMI.

Variables	Correlation
Psoas muscle area index (cm ² /m ²)	r=0.58
Psoas muscle volume index (cm ³ /m ²)	r=0.62
BMI (kg/m ²)	r=0.57
Age (y)	r=-0.25

oral intake. Consequently, in contrast to healthy individuals, among patients with GI tract cancers, the root of sarcopenia seems complicated. Through this validation with InBody 770, we launched a nutritional prehabilitation project (approved by the Institutional Review Board at Sakai City Medical Center, Ref No. 102) for patients with sarcopenia, which we applied during the waiting period. InBody 770 enabled rapid screening for detecting sarcopenia at the first outpatient visit, following a sufficient intervention period, without postponing the scheduled date of surgery. To our knowledge, this study was the first to test the efficacy of InBody 770 as a new tool for measuring skeletal muscle mass preoperatively in patients with cancer.

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