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Efficiency of Bioelectric Impedance Analysis as an Evaluation Method of Skeletal Muscle Mass After Gastrectomy

Motonobu Saito, Akiyoshi Seshimo, Kunitomo Miyake, Ryusuke Yamaguchi, Takahiro Okamoto

Department of Surgery 2, Tokyo Women's Medical University, Tokyo, Japan

Objective: This study measured skeletal muscle mass (SMM) in postoperative gastric cancer patients, to compare SMM to traditional postoperative assessment based on anthropomorphic measures and blood tests, and evaluated the methods of SMM measurement.

Summary of Background Data: SMM, which helps to maintain general health and quality of life, is very important. Measurement of total psoas major muscle area (TPA) by computed tomography imaging has recently been reported to be a useful index of SMM.

Methods: This retrospective study included 92 patients who underwent distal gastrectomy for gastric cancer. SMM was measured by TPA index (computed tomography measurement of TPA / square of height) and bioelectric impedance analysis (BIA). Patients were divided into short-term ($<$3 years) and long-term ($\geq$3 years) postoperative follow-up groups. SMM and traditional postoperative assessment, as well as body mass index, albumin, hemoglobin, and total cholesterol, were compared between the 2 groups. The correlations between the TPA index and the SMM of BIA and traditional postoperative assessment were examined by simple regression analysis.

Results: The SMM of BIA was 24.1 $\pm$ 4.1 kg in the short-term and 22.0 $\pm$ 4.7 kg in the long-term group ($P = 0.02$), and TPA index was 783.4 $\pm$ 166.9 mm^2/m^2 in the short-term and 687.5 $\pm$ 167.2 mm^2/m^2 in the long-term group ($P = 0.01$), whereas there were no significant differences in traditional postoperative assessment. On simple regression analysis, TPA index showed the strongest correlation with SMM of BIA ($R = 0.56$).

Corresponding author: Akiyoshi Seshimo, MD, PhD, Department of Surgery 2, Tokyo Women's Medical University, 8-1 Kawada-cho, Shinjuku-ku, Tokyo 162-8666, Japan.
E-mail: seshimo.akiyoshi@twmu.ac.jp

Conclusions: Measurement of SMM is essential because the traditional postoperative assessments do not reflect the change in SMM. And SMM measurement, especially by BIA, would be useful.

Key words: Gastric cancer – Postoperative assessment – Skeletal muscle mass – Total psoas major muscle – Bioelectric impedance analysis

Nutritional status in postoperative gastric cancer patients is often poor because of reduced food intake. In addition, loss of skeletal muscle mass (SMM), which is often reduced with aging and longer postoperative follow-up periods, impairs general health status and reduces quality of life.[1] Therefore, continuous SMM assessment is required after surgery for gastric cancer. Anthropomorphic measures and blood tests are routinely measured as conventional postoperative follow-up assessments, but body composition analysis including SMM is generally not performed.

New concepts, such as sarcopenia and the locomotive syndrome, have recently been proposed. SMM affects the maintenance of general health and quality of life. Although the importance of evaluating SMM is now recognized, few objective methods for its evaluation are being used in clinical practice.

For body composition analysis, measurement of total psoas major muscle area (TPA) by computed tomography (CT) imaging has recently been reported to be a useful index of total SMM.[2] In addition, bioelectric impedance analysis (BIA) is convenient and highly accurate for the evaluation of body composition, including SMM.[3,4]

The aims of the current study were to evaluate the change of SMM after gastrectomy and to assess the evaluation methods of SMM.

Patients and Methods

Patients

A total of 92 patients who were being followed up at our hospital after distal gastrectomy for gastric cancer were included in this retrospective study. An inclusion criterion was performance status of 0 or 1. Patients with cancer recurrence were excluded.

This study was approved by the ethics review board of Tokyo Women's Medical University (ethics committee approval No. 2826).

Measurement of SMM

SMM was measured by 2 methods: TPA and BIA. TPA (mm^2) was measured by CT imaging at the level of the third/fourth lumbar vertebral body (L3/L4). Bilateral TPAs were totaled to take into account left-right body differences. To correct physical size, the TPA index (mm^2/m^2) was defined as the bilateral TPA area divided by the square of the height (right TPA + left TPA) / ($height^2$). SMM and percent body fat were measured by BIA using an InBody 720 analyzer (InBody 720, Biospace, Tokyo, Japan). BIA was performed at the same time as CT imaging.

Traditional postoperative follow-up assessment

Anthropomorphic measurements and blood tests were performed at the same time as CT imaging. Body mass index (BMI) was used as an anthropomorphic measure. Blood tests included albumin (Alb; g/dL), hemoglobin (Hb; g/dL), and total cholesterol (T-chol; mg/dL).

Postoperative follow-up period

To compare the effect of postoperative follow-up duration, the patients were divided into 2 groups: postoperative follow-up duration less than 3 years (short-term group), and 3 years or longer (long-term group). The TPA index, SMM with BIA, percent body fat, BMI, Alb, Hb, and T-chol were compared between the 2 groups.

Statistical analysis

The data were analyzed using nonparametric Wilcoxon 2-sample test and χ^2 test for the comparison of the 2 groups. The correlations of the TPA index with SMM of BIA, percent body fat, BMI, Alb, Hb, and T-chol were examined by simple regression analysis. Statistical analysis was performed using JMP version 10 (SAS Institute, Cary, North Carolina). Values of $P < 0.05$ were considered significant.

Table 1 Patients' characteristics

	Short-term group (n = 45)	Long-term group (n = 47)	*P* value
Postoperative follow-up duration, mo	14	61	
Age, y (mean ± SD)	66.6 ± 11.7	70.2 ± 10.7	NS
Sex, n			NS
Male	34	29	
Female	11	18	
Stage, n			NS
I	29	34	
II	10	4	
III	5	8	
Unknown, n	1	1	
Reconstruction method, n			NS
Billroth I reconstruction method	37	38	
Roux-en-Y reconstruction method	9	8	

NS, not significant.

Results

Patients' characteristics for the 2 groups

Table 1 shows the patients' characteristics for the 2 groups. There were no significant differences in age, sex, stage (Union for International Cancer Control classification), or surgical reconstruction method between the 2 groups.

Traditional postoperative assessment and body composition analysis

There were no significant differences in anthropomorphic measures or blood test results between the 2 groups (Table 2). The results of BIA also showed no significant difference in percent body fat between the 2 groups. However, the SMM with BIA was 24.1 ± 4.1 kg in the short-term group and 22.0 ± 4.7 kg in the long-term group, which showed a significant decrease in the long-term group ($P = 0.02$). The TPA index was 783.4 ± 166.9 mm^2/m^2 in the short-term group and 687.5 ± 167.2 mm^2/m^2 in the long-term group, which also showed a significant decrease in the long-term group ($P = 0.01$; Table 3).

Table 2 Traditional postoperative assessment

	Short-term group (n = 45) mean ± SD	Long-term group (n = 47) mean ± SD	*P* value
BMI, kg/m^2	21.1 ± 3.0	20.6 ± 3.2	NS
Alb, g/dL	4.2 ± 0.1	4.2 ± 0.1	NS
Hb, g/dL	13.2 ± 1.4	13.2 ± 1.1	NS
T-chol, mg/dL	185.8 ± 31.7	195.6 ± 31.4	NS

Table 3 Body composition analysis

	Short-term group (n = 45) mean ± SD	Long-term group (n = 47) mean ± SD	*P* value
Percent body fat	21.0 ± 7.2	22.0 ± 7.9	NS
SMM of BIA, kg	24.1 ± 4.1	22.0 ± 4.7	0.02
TPA index, mm^2/m^2	783.4 ± 166.9	687.5 ± 167.2	0.01

Evaluation of the TPA index method

The results of the correlations of the TPA index are shown in Table 4. There were positive correlations with BMI, SMM with BIA, and Hb. The correlation coefficients were: SMM, 0.56 (Fig. 1A); Hb, 0.49 (Fig. 1B); and BMI, 0.48 (Fig. 1C). The correlation between the TPA index and SMM with BIA was the strongest.

Discussion

Sarcopenia, which refers to age-associated loss of SMM and function, was first proposed by Rosenberg[5] in 1989. Since the first proposal, evaluation of SMM and prevention of SMM loss, which may affect the maintenance of general health and quality of life, have been gaining recognition.[5–8] Also, it was suggested that sarcopenia may be accelerated by numerous factors, including inactivity, poor nutrition, and chronic illness.[9] In this regard, analysis of SMM in postoperative gastric cancer patients is important.

The present study investigated SMM and compared it to traditional postoperative assessment based on anthropomorphic measures and blood testing in patients who underwent distal gastrectomy for gastric cancer. The patients were divided into 2 groups by a follow-up period of 3 years, when

Table 4 Evaluation of the TPA index method

Parameter	Simple regression analysis, *P* value	*R* value
BMI	<0.01	0.48
SMM of BIA	<0.01	0.56
Percent body fat	NS	—
Alb	NS	—
Hb	<0.01	0.49
T-chol	NS	—

NS, not significant.

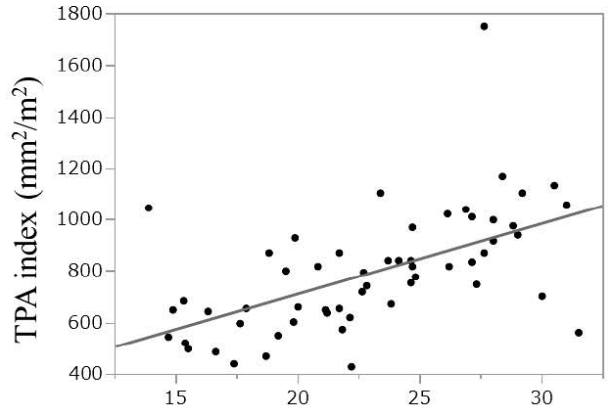

Fig. 1A Skeletal muscle mass (kg)

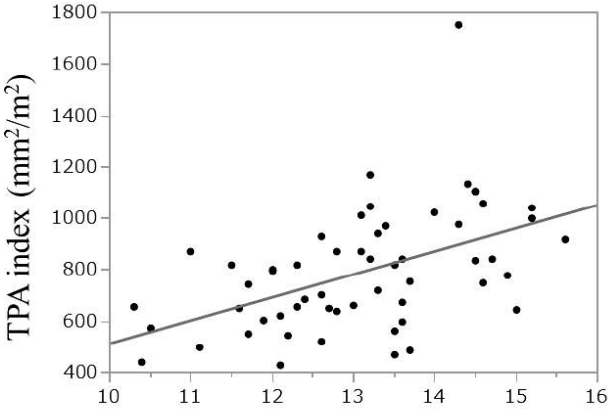

Fig. 1B Hb(g/dl)

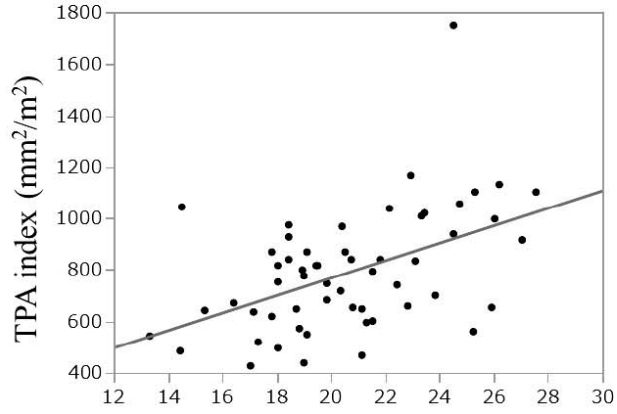

Fig. 1C BMI (kg/m²)

Fig. 1 Result of a regression analysis regarding the TPA index. (A) SMM of BIA, $R = 0.56$. (B) Hb, $R = 0.49$. (C) BMI, $R = 0.48$.

postoperative symptoms would generally be regarded as stable.

Anthropomorphic measures and results of blood tests, used for traditional postoperative assessment, did not differ significantly between the 2 groups, but the TPA index and SMM of BIA were significantly lower in the long-term follow-up group. It was therefore suggested that long-term evaluation of SMM after distal gastrectomy is important. It was also estimated that postoperative SMM cannot be evaluated only by evaluating traditional postoperative assessment measures. Therefore, a comprehensive evaluation of body composition, including SMM, is necessary in postoperative gastric cancer patients.

However, it is difficult to estimate whether the results are influenced only by surgery, because we are not able to follow the change over time in the same patients because of the lack of preoperative measurements. This is a limitation of this article.

There are few objective methods of evaluation actually used in clinical practice. This study therefore focused on the evaluation methods of SMM. Measurement of TPA has been widely used as a useful index of total SMM.[2,7] The psoas major muscle plays a major role in posture and motor function. Associations of TPA with muscle mass, walk function, and exercise capacity have been suggested in orthopedics and rehabilitation medicine. Recently, a relationship between TPA and postoperative nutritional status and cachexia has also been reported in gastrointestinal cancer.[10–14]

However, because TPA is measured by CT imaging, radiation exposure is a concern, and the measurement techniques are complex. On the other hand, in BIA, body composition is analyzed by measuring resistance to weak currents at multiple frequencies. This enables analysis of body composition, such as body fat and SMM. The InBody 720 analyzer, used in the present study, provides high reproducibility and accurate body impedance measurements by using an 8-point tactile electrode system and multiple frequencies.[3,4] Measurements with the InBody 720 to assess changes in body composition have been used clinically in cardiac disease and dialysis patients (*e.g.*, cardiothoracic ration, dry weight adjustment).The InBody 720 has been used for nutritional evaluation in elderly, anemic, lean, amenorrheic, and intensive care unit patients, as well as for evaluation of obesity. Therefore, BIA would be more noninvasive and give more precise methods of SMM measurement than TPA.

The results of simple regression analysis, used to examine the correlations of the TPA index, with other evaluation methods revealed the strongest correlation with SMM using BIA. This result may support the idea that SMM measured with BIA will be a useful and noninvasive index for SMM.

Conclusion

The evaluation of SMM, which helps to maintain general health, is necessary in postoperative gastric cancer patients. The traditional postoperative assessment does not reflect the change in SMM.

For the evaluation of SMM, TPA index showed the strongest correlation with SMM of BIA; the evaluation method for this is convenient and noninvasive. Therefore, SMM of BIA is considered to be a useful parameter in postoperative assessment for gastric cancer.

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The authors declare no conflicts of interest.

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