



Preoperative Sarcopenia and Postoperative Morbidity after Surgery for Gastric and Colon Cancer: A Single-Center Observational Study

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Abstract

Background: Sarcopenia is increasingly being recognized as a clinically relevant marker of physiological vulnerability in patients undergoing cancer surgery. However, its effect on short-term postoperative morbidity and long-term outcomes after gastric and colon cancer surgery remains insufficiently defined, particularly in small community-based cohorts assessed using the Asian Working Group for Sarcopenia (AWGS) 2014 criteria.

Methods: This retrospective, observational study included 41 patients who underwent surgery for gastric or colon cancer at a single institution in Japan. Preoperative sarcopenia was assessed using bioelectrical impedance analysis and handgrip strength, according to the AWGS 2014 criteria. The patients were classified into sarcopenia and non-sarcopenia groups. The short-term outcomes included overall postoperative complications and surgical site infections (SSI). The long-term outcomes included overall survival and relapse-free survival. Multivariate analysis was performed to evaluate the association between sarcopenia and postoperative complications.

Results: Sarcopenia was identified in 21 (51.2%) patients. Patients with sarcopenia were older and had a lower body mass index, skeletal muscle mass index, handgrip strength, and nutritional indices than those without sarcopenia. Overall, postoperative complications were more frequent in the sarcopenia group than in the non-sarcopenia group (38.1% vs. 10.0%), whereas the incidence of SSI was similar between groups. In multivariate analysis, sarcopenia remained associated with postoperative complications, although the wide confidence interval indicated limited precision due to the small number of events. Overall and relapse-free survival tended to be poorer in patients with sarcopenia; however, these differences were not statistically significant.

Conclusions: Preoperative sarcopenia assessed using the AWGS 2014 criteria was associated with increased postoperative morbidity after gastric and colon cancer surgery. The absence of a clear association with SSI suggests that sarcopenia may reflect a broader physiological vulnerability than infection-specific risk alone. Routine assessment of muscle mass, muscle strength, and nutritional status may help improve perioperative risk stratification and guide prehabilitation or nutritional intervention.

Keywords: Sarcopenia; Gastrointestinal cancer; Surgical site infection; Postoperative morbidity; Gastric cancer; Colon cancer

Introduction

Sarcopenia is a progressive and generalized skeletal muscle disorder characterized by reduced muscle mass and impaired muscle strength or physical performance. It was initially recognized as an age-related condition but is now widely understood as a multifactorial syndrome associated with malignancy, chronic inflammation, malnutrition, reduced physical activity, and systemic catabolism. Sarcopenia has attracted increasing attention in the field of surgical oncology because it may represent a clinically measurable marker of physiological reserves and vulnerability.

In 2014, the Asian Working Group for Sarcopenia (AWGS) proposed the diagnostic criteria for sarcopenia, emphasizing the assessment of both skeletal muscle mass and muscle strength or physical performance in Asian populations. These criteria are particularly relevant in Japanese surgical cohorts, where the body composition and muscle mass distribution may differ from those

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of Western populations. Bioelectrical impedance analysis (BIA) is a practical, non-invasive, and repeatable method for assessing skeletal muscle mass in routine clinical settings [1].

Increasing evidence suggests that sarcopenia is associated with adverse outcomes after surgery for gastrointestinal cancer. Previous systematic reviews and meta-analyses of gastrointestinal cancer surgeries have reported that sarcopenia is associated with increased postoperative complications, longer hospital stays, and poorer survival. In colorectal cancer surgery, sarcopenia has been linked to postoperative morbidity, although the strength of the association varies according to the cancer stage, operative approach, sarcopenia definition, and the method used to measure skeletal muscle mass. In gastric cancer, a low skeletal mass index (SMI) and sarcopenia have been associated with impaired overall and disease-free survival in several meta-analyses.

However, several clinically relevant issues remain unresolved. First, many previous studies used computed tomography (CT)-based skeletal muscle measurements, which may not always be available or routinely analyzed in community hospitals. Second, the relationship between sarcopenia and specific types of postoperative complications, including surgical site infections (SSI), remains inconsistent. Third, the evidence from small Japanese cohorts using the AWGS 2014 criteria remains limited [2]. Fourth, it is unclear whether sarcopenia should be interpreted primarily as a risk factor for infectious complications, or as a broader marker of frailty, malnutrition, and reduced physiological reserves.

Therefore, this study aimed to evaluate the association between preoperative sarcopenia, as assessed according to the AWGS 2014 criteria, and short-term postoperative morbidity in patients undergoing surgery for gastric or colon cancer. We also explored the association between sarcopenia and long-term survival. We hypothesized that sarcopenia would be associated with increased overall postoperative complications, but not necessarily with SSI alone.

Materials and Methods

Study design and patients

This retrospective observational study included patients who underwent surgery for gastric or colon cancer at the Department of Surgery of Shikoku Central Hospital, Japan. Patients were included if they had undergone elective surgery with curative or palliative intent and had available preoperative body composition and muscle strength data. Patients with missing sarcopenia assessment data or insufficient postoperative outcome data were excluded.

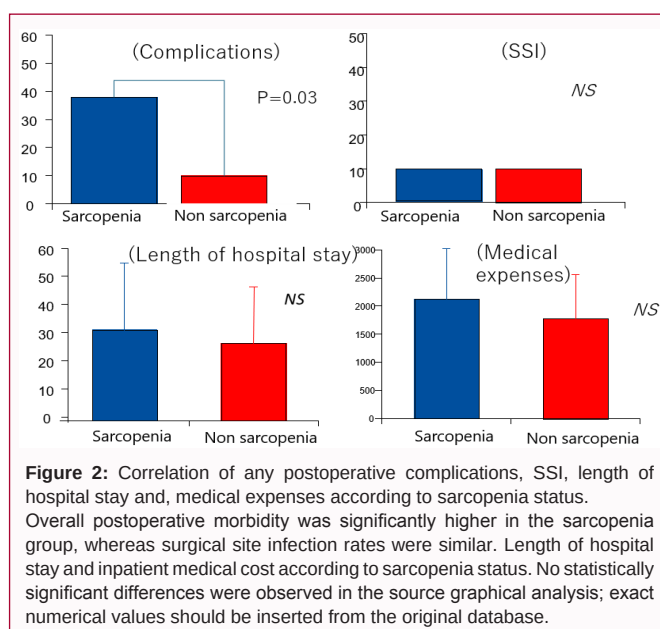
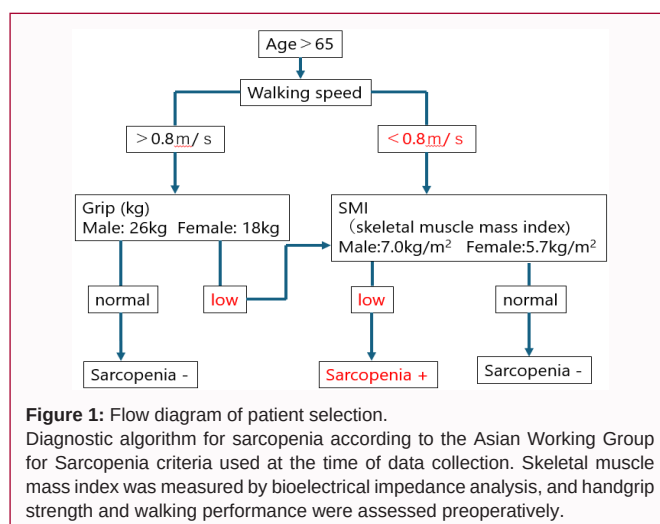
A total of 41 patients were included in the analysis. The patients were divided into two groups according to the presence or absence of sarcopenia: a sarcopenia group and a non-sarcopenia group [3-5].

Assessment of sarcopenia

Sarcopenia was diagnosed based on the AWGS 2014 criteria. Skeletal muscle mass was assessed using BIA, and skeletal muscle mass index (SMI) was calculated as the appendicular skeletal muscle mass divided by height squared (kg/m^2). Muscle strength was assessed by handgrip strength. Patients with low skeletal muscle mass and muscle strength were classified as having sarcopenia according to the AWGS 2014 cut-off values.

Clinical variables

Clinical variables included age, sex, body mass index (BMI),



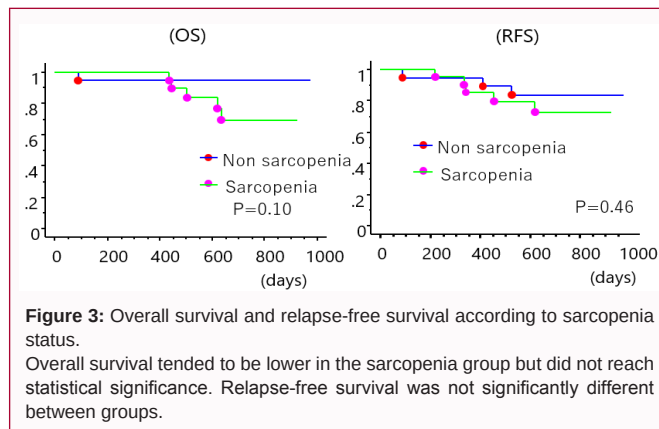
cancer type, operative procedure, surgical approach, clinical stage, laboratory data, nutritional status, SMI, and handgrip strength. Nutritional status was evaluated using serum albumin levels and the Geriatric Nutritional Risk Index, when available.

Outcomes

The primary outcome was overall postoperative morbidity. Postoperative complications were graded according to the Clavien-Dindo classification, and clinically relevant complications were defined as grade II or higher. SSI were evaluated separately as infectious complications. Secondary outcomes included postoperative hospital stay, overall survival, and relapse-free survival (Figures 1-3).

Statistical analysis

Continuous variables are presented as mean $\pm$ standard deviation or median with interquartile range, as appropriate. Categorical variables are presented as numbers and percentages. Between-group comparisons were performed using Student's t-test, Mann-Whitney U test, chi-square test, or Fisher's exact test, as appropriate. Survival outcomes were estimated using the Kaplan-Meier method and compared using the log-rank test.



Multivariate logistic regression analysis was performed to evaluate the association between sarcopenia and postoperative complications. Considering the small number of patients and events, the number of variables included in the model was limited to avoid overfitting. ORs and 95% confidence intervals were determined. Statistical significance was defined as a two-sided P-value of <0.05.

Results

Patient characteristics

Among the 41 patients included in the study, 21 (51.2%) were classified as having sarcopenia and 20 (48.8%) as not having sarcopenia. Patients with sarcopenia were generally older and had lower BMI than those without sarcopenia. Sex distribution also differed between the groups. As expected, the SMI and handgrip strength were lower in the sarcopenia group than in the non-sarcopenia group [6,7].

Nutritional marker levels tended to be lower in patients with sarcopenia, suggesting that sarcopenia is accompanied by impaired nutritional and physiological reserves. The clinicopathological factors, including cancer type and disease stage, were broadly comparable between the groups.

Postoperative outcomes

Overall, postoperative complications occurred more frequently in the sarcopenia group than in the non-sarcopenia group (38.1% vs. 10.0%). In contrast, the incidence of SSI did not differ substantially between the two groups. These findings suggest that sarcopenia is more strongly associated with overall postoperative morbidity than with SSI.

In multivariate analysis, sarcopenia remained associated with postoperative complications, although the wide confidence interval indicated limited precision due to the small number of events. Therefore, this association should be interpreted with caution and require validation in larger cohorts.

Survival outcomes

Kaplan-Meier analysis showed that overall survival tended to be poorer in patients with sarcopenia than in those without, although the difference was not statistically significant. Relapse-free survival also showed no significant differences between the groups. These results suggest that the present study might have been underpowered to detect differences in long-term outcomes (Tables 1-4).

Discussion

In this retrospective study of patients who underwent surgery

Table 1: Baseline characteristics of patients with and without sarcopenia.

Variable	Sarcopenia (n=21)	Non-sarcopenia (n=20)	P value
Age, years	77.8 +/- 8.1	71.4 +/- 7.1	0.008
Male sex	8 (38%)	16 (80%)	0.006
Female sex	13 (62%)	4 (20%)	0.006
BMI, kg/m ²	19.8 +/- 3.1	23.3 +/- 2.8	0.0003
Grip strength, kg	21.0 +/- 7.6	30.2 +/- 9.9	0.001
Walking test value	10.6 +/- 4.2	8.8 +/- 2.7	0.1
SMI, kg/m ²	5.4 +/- 0.8	7.1 +/- 0.8	0.00006
Albumin, g/dL	3.7 +/- 0.7	4.1 +/- 0.5	0.05
Prealbumin	18.0 +/- 5.2	23.9 +/- 6.1	0.001
Procalcitonin	0.08 +/- 0.07	0.07 +/- 0.06	0.67
ConA response	18,978 +/- 6,987	20,363 +/- 7,341	0.55
Lymphocyte count	1,850 +/- 460	1,980 +/- 520	0.12
GNRI	82 +/- 11	98 +/- 10	0.001

BMI: Body Mass Index; Con A: Concanavalin A Response; GNRI: Geriatric Nutritional Risk Index; SMI: Skeletal Muscle Mass Index

for gastric or colon cancer, preoperative sarcopenia, as assessed according to the AWGS 2014 criteria, was associated with increased overall postoperative morbidity. However, sarcopenia was not clearly associated with SSI. The long-term survival outcomes tended to be poorer in patients with sarcopenia; however, these differences were not statistically significant.

These findings are consistent with those of previous systematic reviews and meta-analyses showing that sarcopenia is associated with adverse outcomes after surgery for gastrointestinal cancer. Sarcopenia has been reported to increase the risk of postoperative morbidity in patients undergoing colorectal cancer surgery, although the heterogeneity among studies remains substantial. In gastric cancer, low SMI and sarcopenia have been associated with poor survival, suggesting that skeletal muscle depletion may reflect not only surgical risk but also cancer-related systemic vulnerability [8-10].

An important finding of this study was that sarcopenia was associated with overall complications but not with SSI. This distinction may be clinically relevant. SSI are influenced by multiple procedure-specific factors, including wound classification, operative duration, blood loss, surgical approach, bowel preparation, and perioperative antibiotic prophylaxis. In contrast, the overall postoperative morbidity includes a broader range of complications, such as pulmonary complications, delayed recovery, ileus, cardiovascular events, and general deterioration. Therefore, sarcopenia may function less as an infection-specific predictor and more as an integrated marker of reduced physiological reserves, impaired nutritional status, systemic inflammation, and frailty.

The use of the AWGS 2014 criteria is another clinically relevant feature of this study. These criteria were developed for Asian populations and are suitable for use in Japanese patients. BIA is practical for routine perioperative assessment because it is non-invasive, inexpensive, and repeatable. Although CT-based SMI measurements are widely used in oncological research, BIA-based evaluation may be easier to implement in daily clinical practice, particularly in community hospitals.

These results support the importance of preoperative optimization. Contemporary perioperative care increasingly

Table 2: Operative and clinicopathological characteristics according to sarcopenia status.

Variable	Sarcopenia (n=21)	Non-sarcopenia (n=20)	P value
Gastric cancer	3 (14%)	10 (50%)	0.01
Colon cancer	18 (86%)	10 (50%)	0.01
Stage I/II/III	09-06-2006	08-05-2007	Not significant
Laparoscopic approach	14 (67%)	9 (45%)	0.16
Open approach	7 (33%)	11 (55%)	0.16
Operative time, min	181 +/- 31	179 +/- 45	0.87
Blood loss, mL	198 +/- 56	233 +/- 48	0.03
LN dissection D1/D2/D3	08-09-2004	06-12-2002	Not significant

LN: Lymph Node; Staging edition and detailed pathological criteria should be verified before final submission.

Table 3: Postoperative outcomes according to sarcopenia status.

Outcome	Sarcopenia (n=21)	Non-sarcopenia (n=20)	P value
Overall postoperative complications	8 (38.1%)	2 (10.0%)	0.03
Superficial SSI	2 (9.5%)	2 (10.0%)	0.96
Deep SSI	0	0	0.96
Ileus	3 (14%)	0	0.002*
Pneumonia	1 (4.8%)	0	0.002*
Ascites	1 (4.8%)	0	0.002*
Cardiac complication	1 (4.8%)	0	0.002*

*P value corresponds to the comparison of non-SSI complications in the source analysis.

SSI: Surgical Site Infection

Table 4: Statistical analysis of factors associated with postoperative complications.

Factor	Univariable estimate (95% CI)	P value	Multivariable estimate (95% CI)	P value
Age >75 years	2.1 (0.33-5.98)	0.64	2.2 (0.10-4.04)	0.41
Female sex	2.1 (0.25-4.63)	0.91	4.2 (0.18-17.3)	0.21
Sarcopenia	2.4 (1.02-30.5)	0.04	2.3 (1.06-16.5)	0.03
Serum albumin	1.9 (0.11-3.03)	0.05	0.6 (0.10-4.04)	0.63
Prealbumin	2.6 (0.69-3.94)	0.01	0.8 (0.60-1.10)	0.45
BMI	2.3 (0.57-4.95)	0.02	0.9 (0.47-1.40)	0.45
SMI	1.6 (0.33-5.20)	0.19	0.9 (0.05-14.3)	0.94

The original poster table labelled these estimates as HR. For postoperative complications, they should be reported as odds ratios or model-derived risk estimates after confirming the original statistical model.

CI: Confidence Interval; BMI: Body Mass Index; SMI: Skeletal Muscle Mass Index

emphasizes prehabilitation, nutritional therapy, and multimodal enhanced recovery pathways. The ESPEN guidelines recommend nutritional assessments and interventions for patients at nutritional risk who are undergoing major surgery. The ERAS guidelines also emphasize perioperative nutritional care, early mobilization, and the reduction of surgical stress. For patients with sarcopenia, combined nutritional support and exercise-based prehabilitation may be particularly important, although the optimal intervention strategy and timing remain to be established.

This study had several limitations. First, this was a retrospective single-center study with a small sample size. Second, the number of postoperative events was limited, and the multivariate analysis may have been underpowered; the wide confidence interval indicated limited precision. Third, gastric and colon cancers were analyzed together, although the operative procedures, complication profiles, and oncological outcomes differed between these diseases. Fourth, sarcopenia was assessed using BIA rather than CT-based skeletal muscle measurements, which may limit comparability with previous studies. Fifth, physical performance measures such as gait speed

were not fully evaluated. Sixth, treatment-related factors including perioperative nutritional support and postoperative chemotherapy were not fully considered.

Despite these limitations, the findings of this study suggest that routine preoperative assessment of sarcopenia using practical methods may improve perioperative risk stratification in patients undergoing surgery for gastric or colon cancer. Larger prospective studies are needed to validate these findings and determine whether targeted prehabilitation or nutritional intervention can reduce postoperative morbidity in patients with sarcopenia.

Conclusions

Preoperative sarcopenia, assessed according to the AWGS 2014 criteria, was associated with increased overall postoperative morbidity in patients undergoing surgery for gastric or colon cancer. Sarcopenia was not clearly associated with SSI, suggesting that it may reflect a broader physiological vulnerability than infection-specific risk alone. In multivariate analysis, sarcopenia remained associated with postoperative complications, although the wide confidence

interval indicated limited precision due to the small number of events. Routine assessments of muscle mass, muscle strength, and nutritional status may help identify high-risk patients and guide perioperative optimization strategies.

Author Contributions

Conceptualization, M.I.; literature collection, Y.T. and K.M.; writing--original draft preparation, M.I. and K.M.; writing--review and editing, H.T.; figures and tables, T.M.; supervision, M.I. All authors have read and agreed to the published version of the manuscript.

Compliance with Ethical Standards

All procedures were performed in accordance with the ethical standards of the responsible committee on human experimentation at Shikoku Central Hospital and with the Declaration of Helsinki of 1964 and its later amendments. Informed consent or an appropriate substitute for it was obtained from all patients included in the study.

Conflicts of Interest

The authors declare no conflicts of interest. No funders had any role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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