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Original Research

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The Predictive Values of Five Sarcopenia Screening Tools on Clinical Outcomes Following Surgery in Patients with Gastric Cancer: A Prospective Cohort Study

J.-L. Lu[1,2,], X.-Y. Xu[3,*], L. Chen[2], L.-Y. Ding[1], J.-M. Hu[1], W.-Y. Li[1], S.-Q. Zhu[1], Q. Xu[1]*

1. School of Nursing, Nanjing Medical University, Nanjing, China; 2. Department of Gastric Surgery, the First Affiliated Hospital of Nanjing Medical University, Nanjing, China; 3. Faculty of Health, Queensland University of Technology, Brisbane, Australia; * These authors are co-first author.

Corresponding Author: Qin Xu, Professor of Nursing, School of Nursing, Nanjing Medical Universirty, 140 Hanzhong Road, Gulou District, Nanjing, 210029, Jiangsu Province, China, E-mail: qinxu@njmu.edu.cn; Shu-qin Zhu, Associate Professor of Nursing, School of Nursing, Nanjing Medical University, 140 Hanzhong Road, Gulou District, Nanjing, 210029, Jiangsu Province, China, E-mail: zsq@njmu.edu.cn

Abstract

BACKGROUND: The association between strength, assistance with walking, rise from a chair, climb stairs and falls (SARC-F), strength, assistance with walking, rise from a chair, climb stairs, falls and calf circumference (SARC-CalF), Ishii score chart, the short version of mini sarcopenia risk assessment (MSRA-5), the full version of mini sarcopenia risk assessment (MSRA-7) and clinical outcomes in patients with gastric cancer were unclear. We aimed to investigate the predictive values of the above five sarcopenia screening tools on clinical outcomes following surgery in patients with gastric cancer.

METHODS: The clinical data of consecutive patients who would undergo gastrectomy from May 2020 to October 2020 at the First Affiliated Hospital of Nanjing Medical University were prospectively collected. On the first admission day, patients' characteristics, Nutrition risk screening 2002 (NRS 2002), the above five sarcopenia screening tools and anthropometric measurements were preoperatively collected. Within 24 hours after discharge, operation information, tumor-node-metastasis (TNM) stage and clinical outcomes in hospital (postoperative complications, hospitalization expenditures and postoperative hospital stay) were collected. Three months after discharge, clinical outcomes out of hospital (hospital readmissions and mortality) were collected. Multivariate analyses were conducted to identify the independent predictors for clinical outcomes.

RESULTS: A total of 263 patients were finally included in the study, with the average age being 62.44 years. The prevalence of sarcopenia risk ranged from 3.42% to 73.76%. For the above five sarcopenia screening tools, multivariate analyses showed that sarcopenia risk indicated by SARC-CalF was an independent predictor for postoperative complications (OR=3.145 [95%CI: 0.594, 16.665], P=0.037), prolonged postoperative hospital stay (B=2.383 [95%CI: 0.377, 4.388], P=0.020), increased hospitalization expenditures (B=1.305 [95%CI: 0.402, 2.208], P=0.005) and 3-month hospital readmissions (HR=3.626 [95%CI: 1.126, 11.676], P=0.031). Sarcopenia risk indicated by Ishii score chart was an independent predictor for postoperative complications (OR=6.491 [95%CI: 1.514, 27.840], P=0.012) and hospitalization expenditures (B=0.767 [95%CI: 0.065, 1.469], P=0.032). Sarcopenia risk indicated by MSRA-7 was an independent predictor for prolonged postoperative hospital stay (B=1.636 [95%CI: 0.119, 3.153], P=0.035)and increased hospitalization expenditures (B=0.831 [95%CI: 0.146, 1.516], P=0.018).

CONCLUSION: Among the above five sarcopenia screening tools, SARC-CalF seemed to have better predictive values on clinical outcomes. Preoperative gastric cancer patients with sarcopenia risk indicated by SARC-CalF could have a higher risk of postoperative complications, prolonged postoperative hospital stay, increased hospitalization expenditures and 3-month hospital readmissions.

Key words: Gastric cancer, sarcopenia, screen, predictive values.

Introduction

Gastric cancer is the fifth most common malignancy and the fourth leading cause of cancer-related death worldwide (1). Surgical resection is still the most effective therapeutic treatment. However, gastrectomy was often related to an unsatisfactory clinical prognosis (2).

Sarcopenia is a progressive and generalized skeletal muscle disorder (3). Since 2016, the World Health Organization (WHO)'s International Statistical Classification of Diseases and Related Health Problems (ICD) has recognized sarcopenia as a disease, coding ICD-10-CM (M62.84) (4). It was reported that sarcopenia was more frequent in preoperative patients with gastric cancer than other abdominal tumors (5). Our previous meta-analysis revealed that preoperative sarcopenia was an independent predictor for postoperative complications, longer hospital stay, increased hospitalization expenditures, hospital readmissions and mortality in patients with gastric cancer (6). Moreover, in 2000, it was estimated that direct healthcare cost caused by sarcopenia in America was $18.5 billion, accounting for about 1.5% of total healthcare expenditures for that year (7). Given these factors, it is greatly essential to screen sarcopenia in preoperative patients with gastric cancer so as to prevent or mitigate adverse outcomes, as suggested by International Clinical Practice Guidelines for Sarcopenia (8).

According to our previous literature review (9), sarcopenia screening tools mainly included: (1) questionnaires, such as strength, assistance with walking, rise from a chair, climb stairs and falls (SARC-F) and mini sarcopenia risk assessment (MSRA); (2) anthropometric measurements, such as Ishii score chart; (3) combination of questionnaires and anthropometric measures, such as strength, assistance with walking, rise from a chair, climb stairs, falls and calf circumference (SARC-CalF). Both screening accuracy and prediction on adverse outcomes

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are major factors in evaluating the performance of screening tools. As for the above sarcopenia screening tools, most studies focused on their adaptation, validation and accuracy analysis, and quite a few studies confirmed their satisfactory accuracy for screening sarcopenia (9). However, there were limited studies clarifying their predictive values on health outcomes. Among the existing studies, it was showed that SARC-F-defined sarcopenia risk was independently associated with an increased risk of 1-year mortality in elderly nursing home residents (10). And sarcopenia risk estimated by Ishii score chart could predict 3-year mortality independently in hospitalized older adults (11). In conclusion, relevant studies mostly focused on the elderly and mortality, indicating the predictive values of the above sarcopenia screening tools in patients with gastric cancer needs further exploration, and the other short-term and long-term clinical outcomes except mortality should be also taken into consideration.

The aim of the present study was to analyze the predictive values of the above sarcopenia screening tools on clinical outcomes following surgery in patients with gastric cancer, providing a reference for screening sarcopenia in patients with gastric cancer.

Methods

Study design and participants

For this prospective cohort study, consecutive patients who would undergo gastrectomy from May 2020 to October 2020 at the First Affiliated Hospital of Nanjing Medical University were enrolled. This study was approved by the ethics committee of the First Affiliated Hospital of Nanjing Medical University (NO. 2020-SR-420). The informed consent had been obtained from each patient.

Patients' inclusion criteria were as followed: (1) aged ≥18 years; (2) having an endoscopic or pathological diagnosis of gastric cancer; (3) planning to undergo confine surgery for gastric cancer for the first time. Patients' exclusion criteria were as followed: (1) perioperative death; (2) lost during follow-up after discharge; (3) having received preoperative adjuvant therapy; (4) having psychiatric history or taking psychotropic drugs; (5) accompanied by other sites of malignant tumors; (6) having a physical disability; (7) having edema; (8) equipped with a metal medical device or pacemaker; (9) taking medicines influencing body composition (e.g. diuretics, etc.).

Sarcopenia screening tools

SARC-F is a self-reported questionnaire with 5 items: strength, assistance with walking, rise from a chair, climb stairs and falls (12). The scores range from 0 to 10, with 0 to 2 points for each item. The preliminary study suggested that a score equal to or greater than 4 is predictive of sarcopenia risk. In the Chinese version of SARC-F, the coefficients of Cronbach's α and criterion-related validity were 0.878 and 0.849, respectively, indicating the reliability and validity of the adapted questionnaire was satisfactory (13).

SARC-CalF is a combination of SARC-F and calf circumference (CC) (14). For men and women, the cut-off values of CC are 34 cm and 33 cm, respectively. CC scores 0 for more than the cut-off values, otherwise CC scores 10. Moreover, the other part is line with SARC-F. A total score of 11 or larger out of 20 suggests sarcopenia risk. A study about the indigenous validation of SARC-CalF showed that the tool was acceptable among cancer patients in China, with the area under curve (AUC) being 0.75 in the screening accuracy analysis (15).

Ishii score chart is formulas to estimate the sarcopenia risk for both genders, including three variables: age, grip strength and CC (16). The exact formulas are as followed: for men, $0.62 \times (\text{age} - 64) - 3.09 \times (\text{grip strength} - 50) - 4.64 \times (\text{CC} - 42)$; for women, $0.80 \times (\text{age} - 64) - 5.09 \times (\text{grip strength} - 34) - 3.28 \times (\text{CC} - 42)$. A score ≥105 for men and ≥120 for women is considered as sarcopenia risk. There was also a study about the validation of Ishii score chart showed that the tool had a high accuracy for screening sarcopenia in Chinese geriatric inpatients, with AUC being 0.87 (17).

MSRA is a self-reported questionnaire including objective parameters related to sarcopenia risk onset (18). The tool has two version: the short version (named MSRA-5) and the full version (named MSRA-7). MSRA-5 involves 5 items, including age, physical activity level, hospitalizations, weight loss and the meals number per day. Each item ranges from 0 to 5, 0 to 10 or 0 to 15. Subjects with a score of 45 or less out of a maximum of 60 can be clarified as sarcopenia risk. While MSRA-7 composed of 7 items, with additional assessment of dairy product consumption and protein consumption. Each item ranges from 0 to 5 or 0 to 10. A total score of 30 or less out of 40 reveals sarcopenia risk. A study about the validation of the Chinese version of MSRA showed that both MSRA-5 and MSRA-7 had acceptable AUC, indicating that it was considerable to use MSRA to screen sarcopenia in Chinese community-dwelling older adults (19).

Data collection

On the first admission day, the following preoperative information were collected for each patient in the cohort: (1) Patients' characteristics, including age, gender, marriage, education, comorbidities, medicines, smoking (it was considered positive that smoking occurred at least once in the past year) (20), drinking (it was considered positive that drinking occurred at least once a week in the past year) (21), history of abdominal surgeries, white blood cells, neutrophile granulocyte, hemoglobin and serum albumin, were collected from electronic medical records. (2) Nutrition risk screening 2002 (NRS 2002), a score equal to or larger than 3 out of 7 indicates nutrition risk (22), was investigated by communicating with patients. (3) Summary of the items of the above five sarcopenia screening tools, where duplicate items were only measured once, combined self-report and anthropometric measurements. Thereinto, CC was measured as the maximum horizontal distance around the left calf as the subject stood upright (23). (4) Anthropometric measurements,

including grip strength, appendicular skeletal muscle mass (ASMM), 4-m gait speed and body mass index (BMI). Handgrip strength was measured three times on the dominant hand by an electronic hand dynamometer (EH101, Xiangshan, Guangdong Province, China), with taking the average value as the final result (24). ASMM was measured by bioelectrical impedance analysis (BIA) (InBody BCA-2A, Tongfang, Beijing, China). 4-m gait speed was measured by a stopwatch (DM1-103, Yiwu, Zhejiang Province, China). BMI was measured using electronic body scale (JL-200, Yiwu, Zhejiang Province, China).

Within 24 hours after discharge, the data below were all collected by reviewing and extracting the electronic medical records: (1) Operation information, consisting of operation method, operation type and operation duration. (2) Tumor-node-metastasis (TNM) stage, based on the 8th edition of the American Joint Committee on Cancer (AJCC) staging system for gastric cancer. (3) Clinical outcomes in hospital, including postoperative complications graded by Clavien-Dindo classification (total complications were considered as Clavien-Dindo grade≥2) (6), hospitalization expenditures (costs from admission to discharge) and postoperative hospital stay (duration from operation to discharge).

Three months after discharge, clinical outcomes out of hospital were collected by telephone and clinical visit combined with the inpatient medical record system, including hospital readmissions and mortality. Time to death or hospital readmissions was calculated as the period between the first admission day and the date of death or hospital readmissions. For the above clinical outcomes, the primary outcome was postoperative complications, and secondary outcomes were the others.

Statistical analysis

The PASS 15.0 software (PASS 15 Power Analysis and Sample Size Software, NCSS, LLC) was applied to determinate the sample size. Previous study showed that the prevalence of postoperative complications in patients with gastric cancer was 19.6% (25). Taking an allowable error of 0.1, confidence interval of 95% and miss rate of 5% into account, a minimum sample was 254.

The SPSS 20.0 software (IBM, SPSS Statistics, Armonk, NY, USA) was used to make data description and analysis. The continuous variables were expressed as mean and standard deviation, and the categorical variables were presented as frequency and percentage. In the multivariate analysis, binary logistic regression was used to estimate odds ratio (OR) and their corresponding 95% confidence interval (CI) to identify the independent predictors of postoperative complication. Multiple linear regression was used to calculate B and 95%CI to identify the independent predictors of hospitalization expenditures and postoperative hospital stay. Multivariable Cox proportional hazard regression were used to estimate hazard ratio (HR) and 95%CI to identify the independent predictors of 3-month hospital readmissions and 3-month mortality. Significantly, to avoid the possibility of multicollinearity, variables that might lead to multicollinearity were excluded in each multivariate analysis model, including gender, age, CC and grip strength which overlapped with the above sarcopenia screening tools, and multicollinearity was explained by variance inflation factor (VIF). Besides, in view of a hypothesis-driven approach, enter selection was chosen to force all variables into multivariate analysis models, and the only difference across models was the sarcopenia screening tools. All statistical tests were two-sided and $P<0.05$ was considered statistically significant, VIF>10 was supposed to be with multicollinearity.

Results

Demographic and clinical characteristics

A total of 270 patients with gastric cancer who would undergo gastrectomy were enrolled during the study period. Ultimately, 7 patients were excluded from this study due to incomplete and regular answers, leaving 263 patients included in the final analysis. No significant difference was identified between the included participants and those who were excluded with respect to age, SARC-F, SARC-CalF, Ishii score chart, MSRA-7 and MSRA-5 at the baseline. As showed in Table 1, in this study, female accounted for 75.67%. The average age was 62.44 years and the proportion of the old and nutrition risk was 67.30% and 36.12%, respectively. The prevalence of sarcopenia risk ranged from 3.42% to 73.76%. For the clinical outcomes, the incidence of postoperative complications, 3-month mortality and 3-month hospital readmissions were 11.79%, 4.56% and 9.13%, respectively. The average hospitalization expenditures and postoperative hospital stay were 6.98 ¥10 thousand and 10.45 days, respectively.

The predictive values of five sarcopenia screening tools for postoperative complications

Binary logistic regression demonstrated that TNM stage II, having history of abdominal surgeries, open surgery, increased operation duration, increased 4-m gait speed, sarcopenia risk indicated by SARC-CalF (OR=3.145 [95%CI: 0.594, 16.665], P=0.037) and sarcopenia risk indicated by Ishii score chart (OR=6.491 [95%CI: 1.514, 27.840], P=0.012) were independent predictors for postoperative complications (Table 1 in appendix).

The predictive values of five sarcopenia screening tools for postoperative hospital stay

Multiple linear regression showed that unnormal white blood cells, open surgery, total gastrectomy, increased operation duration, sarcopenia risk indicated by SARC-CalF (B=2.383 [95%CI: 0.377, 4.388], P=0.020) and sarcopenia risk indicated by MSRA-7 (B=1.636 [95%CI: 0.119, 3.153], P=0.035) were independent predictors for prolonged postoperative hospital stay (Table 2 in appendix). Additionally, adjusted R2 of each multiple linear regression model ranged from 0.320 to 0.335, F values ranged from 6.573 to 6.972, P values were all <0.001.

Table 1. Demographic and clinical characteristics of patients with gastric cancer

Variables	Total (n=263)	Female (n=199)	Male (n=64)
Age, years			
The old, ≥60	177 (67.30%)	141 (70.85%)	36 (56.25%)
The younger, <60	86 (32.70%)	58 (29.16%)	28 (43.75%)
BMI, kg/m^2			
Normal weight, 18.5~<24.0	139 (52.85%)	98 (49.25%)	41 (64.06%)
Unnormal weight, <18.5 or ≥24	124 (47.15%)	101 (50.75%)	23 (35.94%)
Marriage			
Married	249 (94.68%)	190 (95.48%)	59 (92.19%)
Not married	14 (5.32%)	9 (4.52%)	5 (7.81%)
Education			
Primary school or below	105 (39.92%)	68 (34.17%)	37 (57.81%)
Middle school	81 (30.80%)	69 (34.67%)	12 (18.75%)
Senior school or above	77 (29.28%)	62 (31.16%)	15 (23.44%)
Comorbidities (e.g. hypertension, diabetes, cardiopathy, etc.)			
Yes	126 (47.91%)	97 (48.74%)	29 (45.31%)
No	137 (52.09%)	102 (51.26%)	35 (54.69%)
Taking medicines			
Yes	206 (78.33%)	154 (77.39%)	52 (81.25%)
No	57 (21.67%)	45 (22.61%)	12 (18.75%)
Tumor-node-metastasis (TNM) stage			
I	78 (29.66%)	55 (27.64%)	23 (35.94%)
II	125 (47.53%)	100 (50.25%)	25 (39.06%)
III	60 (22.81%)	44 (22.11%)	16 (25.00%)
NRS 2002 score, points			
<3	168 (63.88%)	128 (64.32%)	40 (62.50%)
≥3	95 (36.12%)	71 (35.68%)	24 (37.50%)
Smoking (smoked at least once in the past year)			
Yes	118 (44.87%)	117 (58.79%)	1 (1.56%)
No	145 (55.13%)	82 (41.21%)	63 (98.44%)
Drinking (drank at least once a week in the past year)			
Yes	113 (42.97%)	107 (53.77%)	6 (9.38%)
No	150 (57.03%)	92 (46.23%)	58 (90.63%)
History of abdominal surgeries			
Yes	82 (31.18%)	52 (26.13%)	30 (46.88%)
No	181 (68.82%)	147 (73.87%)	34 (53.13%)
White blood cells, 109/L			
Normal, 3.5~9.5	236 (89.73%)	181 (90.95%)	55 (85.94%)
Unnormal, <3.5 or >9.5	27 (10.27%)	18 (9.05%)	9 (14.06%)
Neutrophile granulocyte, 109/L			
Normal, 1.8~6.3	228 (86.69%)	175 (87.94%)	53 (82.81%)
Unnormal, <1.8 or >6.3	35 (13.31%)	24 (12.06%)	11 (17.19%)
Hemoglobin, g/L			
Normal, (male 130~175, female 115~150)	159 (60.46%)	116 (58.29%)	43 (67.19%)
Unnormal, (male<130, female<115 or male>175, female>150)	104 (39.54%)	83 (41.71%)	21 (32.81%)

Table 1 (continued). Demographic and clinical characteristics of patients with gastric cancer

Variables	Total (n=263)	Female (n=199)	Male (n=64)
Serum albumin, g/L			
Normal, 40~55	54 (20.53%)	39 (19.60%)	15 (23.44%)
Unnormal, <40 or >55	209 (79.47%)	160 (80.40%)	49 (76.56%)
Operation method			
Laparoscopic surgery	177 (67.30%)	132 (66.33%)	45 (70.31%)
Open surgery	86 (32.70%)	67 (33.67%)	19 (29.69%)
Operation type			
Subtotal gastrectomy	134 (50.95%)	93 (46.73%)	41 (64.06%)
Total gastrectomy	129 (49.05%)	106 (53.27%)	23 (35.94%)
Grip strength, kg	30.94±9.12	33.94±8.13	21.59±4.53
Appendicular skeletal muscle mass, kg	21.87±3.60	23.08±3.00	18.11±2.59
4-m gait speed, m/s	0.79±0.15	0.80±0.15	0.73±0.15
Calf circumference, cm	33.86±2.74	34.21±2.75	32.79±2.42
Operation duration, min	172.24±45.95	173.41±46.73	168.63±43.57
SARC-F, points			
Sarcopenia risk, ≥4	9 (3.42%)	7 (3.52%)	2 (3.13%)
Non-sarcopenia risk, <4	254 (96.58%)	192 (96.48%)	62 (96.88%)
SARC-CalF, points			
Sarcopenia risk, ≥11	38 (14.45%)	29 (14.57%)	9 (14.06%)
Non-sarcopenia risk, <11	225 (85.55%)	170 (85.43%)	55 (85.94%)
Ishii score chart, points			
Sarcopenia risk, (male≥105, female≥120)	75 (28.52%)	67 (33.67%)	8 (12.50%)
Non-sarcopenia risk, (male<105, female<120)	188 (71.48%)	132 (66.33%)	56 (87.50%)
MSRA-7, points			
Sarcopenia risk, ≤30	194 (73.76%)	148 (74.37%)	46 (71.88%)
Non-sarcopenia risk, >30	69 (26.24%)	51 (25.63%)	18 (28.13%)
MSRA-5, points			
Sarcopenia risk, ≤45	98 (37.26%)	73 (36.68%)	25 (39.06%)
Non-sarcopenia risk, >45	165 (62.74%)	126 (63.32%)	39 (60.94%)
Postoperative complications (Clavien-Dindo≥2)			
Yes	31 (11.79%)	28 (14.07%)	3 (4.69%)
No	232 (88.21%)	171 (85.93%)	61 (95.31%)
3-month mortality			
Yes	12 (4.56%)	11 (5.53%)	1 (1.56%)
No	251 (95.44%)	188 (94.47%)	63 (98.44%)
3-month hospital readmissions			
Yes	24 (9.13%)	23 (11.56%)	1 (1.56%)
No	239 (90.87%)	176 (88.44%)	63 (98.44%)
Postoperative hospital stay, days	10.45±6.23	10.40±5.48	10.61±8.18
Hospitalization expenditures, ¥10 thousand	6.98±2.56	7.03±2.46	6.83±2.88

Annotations: Continuous variables were presented as mean±standard deviation. Categorical variables were presented as frequency (percentage).

Table 2. Summary of the predictive values of five sarcopenia screening tools on clinical outcomes (n=263).

Sarcopenia screening tools	Postoperative complications		Postoperative hospital stay		Hospitalization expenditures		3-month hospital readmissions		3-month mortality	
	OR (95%CI)	P	B (95%CI)	P	B (95%CI)	P	HR (95%CI)	P	HR (95%CI)	P
SARC-F	1.322 (0.057, 30.430)	0.862	0.428 (-0.005, 3.150)	0.814	1.369 (-0.242, 2.979)	0.095	1.714 (0.188, 15.660)	0.633	7.905 (0.836, 74.758)	0.071
SARC-CalF	3.145 (0.594, 16.665)	0.037*	2.383 (0.377, 4.388)	0.020*	1.305 (0.402, 2.208)	0.005**	3.626 (1.126, 11.676)	0.031*	2.545 (0.495, 13.102)	0.264
Ishii score chart	6.491 (1.514, 27.840)	0.012*	0.087 (-1.479, 1.653)	0.913	0.767 (0.065, 1.469)	0.032*	2.293 (0.840, 6.260)	0.105	3.102 (0.713, 13.487)	0.131
MSRA-5	2.078 (0.574, 7.522)	0.265	1.121 (-0.335, 2.578)	0.131	0.315 (-0.346, 0.977)	0.348	2.355 (0.848, 6.535)	0.100	4.315 (0.916, 20.318)	0.064
MSRA-7	4.094 (0.640, 26.194)	0.137	1.636 (0.119, 3.153)	0.035*	0.831 (0.146, 1.516)	0.018*	1.511 (0.459, 4.976)	0.497	3.408 (0.378, 30.749)	0.275

Annotations: Abbreviations: OR, odds ratio; HR, hazard ratio; CI, confidence interval. * indicates P<0.05; ** indicates P<0.01.

The predictive values of five sarcopenia screening tools for hospitalization expenditures

Multiple linear regression showed that increased operation duration, sarcopenia risk indicated by SARC-CalF (B=1.305 [95%CI: 0.402, 2.208], P=0.005), sarcopenia risk indicated by Ishii score chart (B=0.767 [95%CI: 0.065, 1.469], P=0.032) and sarcopenia risk indicated by MSRA-7 (B=0.831 [95%CI: 0.146, 1.516], P=0.018) were independent predictors for increased hospitalization expenditures (Table 3 in appendix). Additionally, adjusted R2 of each multiple linear regression model ranged from 0.177 to 0.201, F values ranged from 3.555 to 3.989, P values were all <0.001.

The predictive values of five sarcopenia screening tools for 3-month hospital readmissions

Multivariate Cox regression analysis indicated that increased operation duration and sarcopenia risk indicated by SARC-CalF (HR=3.626 [95%CI: 1.126, 11.676], P=0.031) were independent predictors for 3-month hospital readmissions (Table 4 in appendix).

The predictive values of five sarcopenia screening tools for 3-month mortality

Multivariate Cox regression analysis indicated that TNM stage II and open surgery were independent predictors for 3-month mortality (Table 5 in appendix).

Summary of the predictive values of five sarcopenia screening tools on clinical outcomes

To sum up, as summarized in Table 2, sarcopenia risk indicated by SARC-CalF was an independent predictor for postoperative complications, prolonged postoperative hospital stay, increased hospitalization expenditures and 3-month hospital readmissions. Sarcopenia risk indicated by Ishii score chart was an independent predictor for postoperative complications and hospitalization expenditures. Sarcopenia risk indicated by MSRA-7 was an independent predictor for prolonged postoperative hospital stay and increased hospitalization expenditures.

Discussion

The present study evaluated the predictive values of the above five sarcopenia screening tools on clinical outcomes following surgery in patients with gastric cancer, providing a clear picture about the predictive values of the existing screening tools. Our study showed that among patients with gastric cancer, the prevalence of sarcopenia risk ranged from 3.42% to 73.76% and SARC-CalF seemed to have better predictive values on clinical outcomes. Preoperative gastric cancer patients with sarcopenia risk indicated by SARC-CalF could have a higher risk of postoperative complications, prolonged postoperative hospital stay, increased hospitalization expenditures and 3-month hospital readmissions.

Our study demonstrated that the average age was 62.44 years and nutrition risk accounted for 36.12% in preoperative patients with gastric cancer, indicating they were characterized by aging and poor nutrition status which were consistent with the risk factors of sarcopenia (26), ultimately leading to a high risk of sarcopenia in these patients. In this study, the prevalence of sarcopenia risk ranged from 3.42% to 73.76%. The great distinction might be attributed to the different measurements of the above tools, involving questionnaires, anthropometric measurements and combination of both. However, our previous study showed that the difference between the screening accuracy of the five sarcopenia screening tools was reasonable using diagnostic criteria proposed by Asian Working Group for Sarcopenia in 2019 (AWGS 2019) (27), with AUC ranging from 0.696 to 0.901 (28).

In our study, sarcopenia risk defined by SARC-F failed to increase the risk of postoperative complications, prolonged postoperative hospital stay, increased hospitalization expenditures, 3-month hospital readmissions and 3-month mortality among patients with gastric cancer, which was inconsistent with previous studies. For example, a previous study involving 329 Chinese nursing home residents showed that SARC-F-defined sarcopenia risk was independently associated with an increased risk of 1-year mortality (HR=1.65 [95%CI:1.04, 2.61]) (10). Besides, another study, using SARC-F, showed that Chinese community-dwelling senior citizens with sarcopenia risk had a higher risk of 4-year mortality (OR=7.35 [95%CI:2.67, 20.18]) (29). The reason for the discrepancy between our study and previous studies might be the different setting, and the former was in hospital and the latter was out of hospital. Moreover, previous studies tended to focus on mortality and lack of attention to other clinical

outcomes. In the future, the prediction of SARC-F on clinical outcomes needs further investigation in hospitalized patients where worse health was often observed.

Our study showed that compared with SARC-F, sarcopenia risk indicated by SARC-CalF had additional predictive values on postoperative complications, prolonged postoperative hospital stay, increased hospitalization expenditures and 3-month hospital readmissions for gastric cancer patients, which might be due to that CC in SARC-CalF was closely associated with muscle mass which was a determinant of sarcopenia (27), moreover, sarcopenia has been widely confirmed as an independent predictor for adverse health-related outcomes in gastric cancer patients (6, 30), ultimately leading to better predictive values of SARC-CalF. Nonetheless, in our study, SARC-CalF failed to predict 3-month mortality, which might be attributed to extremely low mortality in this study. Additionally, in the hospital setting, the association between sarcopenia risk and clinical outcomes in hospitalized patients is supposed to be more consolidated. However, a prospective cohort study showed that for hospitalized patients, SARC-CalF was not an independent predictor of clinical outcomes during the hospitalization neither in the following 6 months of discharge (31). The reason for the contradiction between our study and the prospective cohort study might be the different characteristics of participants. In the prospective study, the sample was overall featured by higher BMI and better health, and it could have contributed to an underestimation of sarcopenia risk and, consequently, the association with outcomes, because patients with high BMI and good health present normal values of CC regardless of possible reduced muscle mass signs in gastrocnemius muscle. In view of this, it reinforced the need of confirmation of our hypothesis by future researches.

Limited studies explored the predictive values of Ishii score chart and MSRA on clinical outcomes, especially for MSRA. There were studies revealing that in geriatric inpatients, sarcopenia risk estimated by Ishii score chart could predict 3-year mortality independently (11), but failed to predict hospital readmissions independently (17). Moreover, it was an independent predictor for postoperative complications and increased hospitalization expenditures in our study, providing a supplement for the prediction of Ishii score chart on clinical outcomes. Additionally, our study showed that sarcopenia risk indicated by MSRA-7 was an independent predictor for prolonged postoperative hospital stay and increased hospitalization expenditures, and that sarcopenia risk indicated by MSRA-5 failed to predict the above five clinical outcomes. The better predictive performance of MSRA-7 than MSRA-5 might be ascribed to that the additional assessments of dairy product consumption and protein consumption in MSRA-7 were closely related to nutrition, moreover, preoperative nutrition might have an immediate effect on postoperative hospital stay and hospitalization expenditures. Accordingly, the predictive values of Ishii score chart and MSRA need further exploration.

Our study has some limitations. First, participants were a single population of gastric cancer patients from one hospital, resulting in the limited representation and small sample size which may influence the extensibility of the results, thus more investigations need to be implemented in other population and centers. Second, follow-up time was only three months so that long-term clinical outcomes require further evaluation in future prospective studies. Third, the clinical outcomes in the present study were limited to objective indicators, and subjective indicators such as quality of life should be taken into consideration in the future.

Conclusion

Among the above five sarcopenia screening tools, SARC-CalF seemed to have better predictive values on clinical outcomes. Preoperative gastric cancer patients with sarcopenia risk indicated by SARC-CalF could have a higher risk of postoperative complications, prolonged postoperative hospital stay, increased hospitalization expenditures and 3-month hospital readmissions. The prediction of the above sarcopenia screening tools on clinical outcomes needs further evaluation in the future.

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