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Article

Analysis of the incidence and influencing factors of sarcopenia in elderly patients with radiation enteritis

Wenwen Fu[1,3,4], Lina Zhang[1,3,4], Tenghui Ma[1,2,3,4] (✉)

[1] *Department of Clinical Nutrition and Microbiology, the Sixth Affiliated Hospital, Sun Yat-sen University, Guangzhou 510655, China*
[2] *Department of Colorectal Anal Surgery, the Sixth Affiliated Hospital, Sun Yat-sen University, Guangzhou 510655, China*
[3] *Guangdong Provincial Key Laboratory of Colorectal and Pelvic Floor Diseases, the Sixth Affiliated Hospital, Sun Yat-sen University, Guangzhou 510655, China*
[4] *Biomedical Innovation Center, the Sixth Affiliated Hospital, Sun Yat-sen University, Guangzhou 510655, China*

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ABSTRACT

Objective: To investigate the incidence of sarcopenia and its influencing factors in elderly patients with chronic radiation proctitis and radiation enteritis.

Results: Patients in the experimental group exhibited significantly lower levels of total cellular fluid volume, total protein content, lean tissue, skeletal muscle mass (SLM), fat-free mass (FFM), appendicular skeletal muscle mass (ASM), relative skeletal muscle mass index (RSMI), visceral fat area (VFA), body mass index (BMI), and phase angle compared to the control group, with statistical significance ($P < 0.05$). Furthermore, within the experimental group, patients with sarcopenia had lower average body mass, BMI, protein levels, ASM, RSMI, body fat, and phase angle compared to those without sarcopenia, with statistical significance ($P < 0.05$). There was a statistically significant difference in the incidence of sarcopenia among different BMI groups within the experimental group ($P < 0.05$). Pearson correlation analysis revealed a significant positive correlation between RSMI and height, body weight, BMI, protein, FFM, SLM, and ASM ($P < 0.001$), while it showed a significant negative correlation with age and percentage of body fat (PBF) ($P < 0.05$). Regression analysis indicated that a higher BMI and ASM were protective factors against the development of sarcopenia in elderly patients with chronic radiation enteritis.

Conclusion: Sarcopenia is highly prevalent in elderly patients with chronic radiation enteritis. Maintaining a suitable high BMI and ASM level is protective against the development of sarcopenia in these patients.

Methods: Elderly patients with chronic radiation enteritis treated at the Sixth Affiliated Hospital, Sun Yat-sen University were selected as the experimental group. Simultaneously, elderly individuals undergoing health check-ups during the same period were chosen as the control group. Relevant parameters of the participants were collected. Diagnoses on whether these patients suffer from sarcopenia were collected.

KEYWORDS

elderly, radiation enteritis, sarcopenia, body composition analysis

1 Introduction

Radiation enteritis refers to intestinal radiation injury that occurs in patients following radiotherapy for pelvic malignancies such as cervical cancer, endometrial cancer, ovarian cancer, prostate cancer, rectal cancer, and bladder cancer [1]. It often manifests approximately three months after the completion of radiation therapy and is characterized by symptoms including rectal bleeding, abdominal pain, anal discomfort, and tenesmus [2]. Due to multiple rounds of radiotherapy and chemotherapy, prior surgeries, tumor burden, and significant psychological stress, patients may experience increased energy expenditure, decreased appetite, and consequently, inadequate caloric intake, leading to weight loss and malnutrition [3]. Literature reports indicate that malnutrition occurs in 53%–68% of patients who develop significant radiation enteritis with intestinal obstruction after pelvic radiotherapy [4]. Elderly patients with radiation enteritis face an even higher risk of malnutrition due to their age. Malnutrition often presents as decreased body mass,

✉ Address correspondence to Tenghui Ma, matengh@mail.sysu.edu.cn

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reduced body fat, abnormal skeletal muscle mass, and muscle strength, severely impacting patients' quality of life, prognosis, and survival. Reduced skeletal muscle mass is the most prominent clinical feature of sarcopenia. Sarcopenia denoted a condition characterized by the progressive reduction of skeletal muscle mass, declining muscle strength, and the development of abnormal muscle physiological functions as individuals age [5]. Sarcopenia can lead to functional impairments in the body, significantly impacting the quality of life and overall health of the elderly population. Additionally, it increases the occurrence of disability and mortality among elderly patients hospitalized with other conditions [6]. As a result, this study conducted body composition measurements on patients diagnosed with radiation enteritis in the hospital. Its main goal was to explore the occurrence of sarcopenia in elderly lung cancer patients with radiation enteritis and examine the factors that influence it. This research aims to provide a foundation for improving the prognosis of elderly patients with radiation enteritis

2 Results

There were no significant differences in age, gender, height, and weight between the two groups ($P > 0.05$). The expression levels of albumin, prealbumin, and hemoglobin in the elderly patients with radiation enteritis were significantly lower than those in the control group, and the difference was statistically significant ($P < 0.05$) (Table 1). The prevalence of sarcopenia in the elderly patients with chronic radiation enteritis group was significantly higher compared to the control group (51.7% vs. 17.7%, $P < 0.05$). Additionally, the total cell fluid volume, total protein content, lean tissue mass, skeletal muscle mass (SLM), fat-free mass (FFM), appendicular skeletal muscle mass (ASM), relative skeletal muscle mass index (RSMI), visceral fat area (VFA), body mass index (BMI), and phase angle were all significantly lower in the chronic radiation enteritis group compared to the control group, and these differences were statistically significant ($P < 0.05$) (Table 2).

Simultaneously, in the sarcopenia group, the average body mass, BMI, protein levels, SLM, ASM, RSMI, BFM, and phase angle were all lower than those in the non-sarcopenia group of elderly chronic radiation patients, with statistically significant differences in all parameters ($P < 0.05$). The differences in the prevalence of sarcopenia among different BMI groups of elderly patients with chronic radiation enteritis were statistically significant ($P < 0.05$) (Tables 3 and 4)

Pearson correlation analysis results indicated a significant positive correlation between RSMI and height, body mass, BMI, protein levels, FFM, SLM, and ASM ($P < 0.001$), and a significant negative correlation with age and PBF ($P < 0.05$). The results of dichotomous logistic regression analysis showed that high BMI and high ASM were protective factors for the development of sarcopenia in elderly patients with chronic radiation enteritis (Tables 5 and 6).

Table 1 Baseline data of patients in both groups

General information	Elderly radiation enteritis group	Control group	*T* value	*P* value
Number	62.00	62.00		
Sex ratio (male/female)	0.07	0.07		
Height	160.31 ± 4.32	160.27 ± 4.39	1.32	>0.05
Age (year)	68.21 ± 2.52	68.29 ± 2.83	1.24	>0.05
Weight (kg)	47.92 ± 0.88	48.10 ± 1.37	−1.73	>0.05
Albumin (g/L)	27.23 ± 4.23	40.27 ± 3.97	4.56	<0.05
Pre-albumin (mg/L)	260.22 ± 63.14	301.78 ± 63.18	9.27	<0.05
Hemoglobin (g/L)	121.74 ± 0.69	129.79 ± 0.35	2.23	<0.05

Table 2 Comparison of the results of body composition analysis between the two groups

Indicators	Elderly radiation enteritis group	Control group	*T* value	*P* value
Total protein (kg)	7.86 ± 1.43	8.70 ± 1.87	−2.89	<0.05
Lean tissue (kg)	26.90 ± 5.73	31.16 ± 6.55	−5.12	<0.05
Specific gravity of fat	0.19 ± 0.06	0.30 ± 0.06	−1.90	0.061
SLM (kg)	24.16 ± 5.31	25.64 ± 9.07	−3.45	<0.05
FFM (kg)	30.09 ± 5.73	31.46 ± 6.55	−3.31	<0.05
ASM (kg)	17.19 ± 2.06	18.30 ± 4.32	−3.02	<0.05
RSMI	6.96 ± 5.31	7.64 ± 9.07	−2.97	<0.05
BFM (kg)	16.93 ± 2.73	17.07 ± 1.38	−1.24	0.834
PBF	36.31% ± 0.28%	35.57% ± 0.40%	−1.52	0.387
VFA (cm)	83.29 ± 0.28	82.86 ± 4.92	−4.16	<0.05
Total cellular fluid volume (L)	30.28 ± 1.12	26.90 ± 1.12	−3.75	<0.05
AMC (cm)	18.29 ± 1.78	18.57 ± 1.62	−1.94	0.059
BMI	18.48 ± 3.61	19.05 ± 2.78	−2.28	<0.05
Phase angle (50 khz)	4.80 ± 1.27	5.23 ± 0.59	−3.17	<0.05

Table 3 Comparison of body composition analysis indicators between sarcopenia patients and non sarcopenia patients in the elderly radiation enteritis group

Indicators	Sarcopenia patients (n = 32)	Non sarcopenia patients (n = 30)	T value	P value
Sex ratio (male/female)	16	15		
Age (year)	68.50 ± 5.21	68.81 ± 4.75	1.39	0.21
Height (cm)	160.24 ± 6.03	160.31 ± 5.18	−1.43	0.15
Body mass (kg)	42.71 ± 7.57	50.29 ± 8.10	−6.29	<0.05
BMI (kg/m^2)	21.32 ± 2.65	23.78 ± 1.98	−3.94	<0.05
Protein (kg)	6.45 ± 0.81	6.81 ± 0.78	−2.60	<0.05
FFM (kg)	30.32 ± 6.24	32.83 ± 6.31	−2.21	0.05
SLM (kg)	24.21 ± 4.18	25.52 ± 4.51	−1.64	0.11
RSMI	5.33 ± 3.51	6.65 ± 3.22	−3.49	<0.05
ASM	15.40 ± 0.13	17.96 ± 0.91	−5.42	<0.05
BFM (kg)	18.06 ± 4.21	20.01 ± 3.96	−2.37	<0.05
PBF	26.45% ± 5.17%	27.43% ± 4.86%	−1.43	0.15
VFA (cm^2)	25.03 ± 3.51	26.5 ± 3.22	−2.19	0.06
AMC	19.43 ± 2.75	22.34 ± 1.79	−1.19	0.32
Phase angle	5.03 ± 2.74	6.03 ± 1.71	−4.50	<0.055
Total cellular fluid volume (L)	30.71 ± 5.64	30.69 ± 4.69	−1.23	0.29

Table 4 Comparison of the prevalence of sarcopenia in different BMI groups in the elderly patients with radiation enteritis group

Groups	BMI			χ^2 value	P value
	Underweight	Normal	Overweight/obese		
Sarcopenia	17 (53.1%)	12 (37.5%)	3 (9.3%)	12.35	<0.05
Non sarcopenia	12 (40.0%)	10 (33.3%)	8 (26.6%)		
Total	29	22	11		

Table 5 Pearson correlation analysis between RSMI and other indicators

Indicators	Age	Height	Body mass	BMI	Protein	FFM	SLM	ASM	BFM	PBF	VFA
R value	−0.42	0.62	0.76	0.51	0.93	0.91	0.93	0.92	0.12	−0.25	0.02
P value	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.231	<0.05	0.90

Table 6 Factors affecting patients with concomitant sarcopenia analyzed by dichotomous logistic regression analysis

Indicators	β	SE	Wald	P value	B	95%CI
BMI	−1.97	0.57	11.34	<0.001	0.14	0.05–0.39
ASM	−2.66	0.84	10.12	0.004	0.08	0.02–0.37

3 Discussion

Sarcopenia is categorized into two main types: primary sarcopenia and secondary sarcopenia [7]. Primary sarcopenia is solely associated with age and lacks other underlying causes [8]. Secondary sarcopenia includes nutrition-related, disease-induced, and exercise-related sarcopenia [9]. Radiation proctitis is a common complication of pelvic malignancies, manifesting mainly as blood in the stool and anal pain, with recurrent symptoms that can significantly affect the quality of life of patients [10]. It has been well documented that radiotherapy, surgery, and tumor are risk factors for malnutrition. Additionally, prominent rectal inflammation symptoms significantly increase psychological stress in patients [11]. Consequently, patients with radiation enteritis have a higher incidence of malnutrition. Most patients with radiation enteritis have symptoms of diarrhea, hematochezia, and pain, and insufficient intake of energy, protein, and vitamins, which can easily lead to secondary muscle wasting [12]. Among them, elderly patients with radiation enteritis are at high risk of secondary muscle wasting due to factors such as age and nutritional status [13]. In recent years, with the increase of incidence rate and mortality of malignant tumors, tumor related sarcopenia has begun to attract widespread attention [14].

For patients with tumor-related wasting disease, their nutritional status plays a very important role in their survival rates [15]. Therefore, it is essential to analyze patients' nutritional status through various methods such as body measurements, body composition analysis, and blood nutritional indicators [16]. Traditional methods of nutritional assessment, including physical examinations and laboratory

tests, have limitations. Physical examinations, such as measuring upper arm muscle circumference and skinfold thickness, are time-consuming and require specialized personnel for accurate measurements [17]. Laboratory tests, such as serum albumin levels, are susceptible to interference from various non-nutritional factors, and the long half-life of serum albumin makes it inadequate for evaluating short-term changes in nutritional status [18]. Body composition analysis, due to its simplicity, non-invasiveness, has gained increasing attention in clinical practice [19]. It has shown superior predictive ability for the survival rates of patients with conditions like HIV/AIDS, lung cancer, hemodialysis patients, and malignancies, compared to other serum or nutritional screening indices, with the assessment of ASM being a vital indicator for muscle mass evaluation [20].

Currently, the primary parameters used for diagnosing and assessing muscle atrophy include muscle mass, muscle strength, and physical function [21]. Muscle mass, in this context, refers to the total quantity of skeletal muscles, and the decline in the quantity and function of limb skeletal muscles is the primary characteristic of muscle atrophy in older individuals. Therefore, ASM is a crucial indicator for evaluating muscle mass, with dual-energy X-ray absorptiometry (DXA) serving as the current gold standard for ASM measurement due to its high accuracy [22]. However, DXA equipment is expensive, non-portable, and involves radiation exposure. In contrast, bioelectrical impedance analysis (BIA), which has been studied for many years, is a cost-effective, non-invasive, and user-friendly method widely used in clinical settings for measuring and assessing body composition, especially muscle mass evaluation [23].

The National Bureau of Statistics of China released significant findings from the seventh national population census on May 11, 2021. These findings revealed a prevailing demographic shift: the population aged 60 and above now totals 264.02 million, constituting 18.70% of the total population [24]. This demographic shift underscores the increasing trend of population aging in society. Sarcopenia, a prominent topic in the field of geriatric medicine, is defined by the gradual reduction of overall skeletal muscle mass that occurs with age. Simultaneously, it presents itself as a geriatric condition characterized by diminished muscle strength and/or physical function in elderly individuals [25]. The 2021 Expert Consensus on Sarcopenia Diagnosis and Treatment in China has reported epidemiological data reflecting sarcopenia prevalence. Among community-dwelling elderly individuals, prevalence ranges from 8.9% to 38.8% [26], while hospitalized elderly patients exhibit even higher rates, ranging from 19.7% to 45.3% [27]. Notably, the prevalence of sarcopenia significantly escalates with advancing age, reaching a staggering 67.1% among those aged 80 and above [28]. Despite the clinical significance of sarcopenia, its comprehensive assessment remains underemphasized in clinical practice and warrants increased attention [29]. The primary objective of this study is to examine the prevalence of sarcopenia and the factors influencing it in elderly patients diagnosed with chronic radiation enteritis. The aim is to establish a robust theoretical framework for future initiatives focused on preventing muscle loss in the elderly. However, it is essential to acknowledge certain limitations in our research, primarily stemming from the limited number of cases due to the specific disease type, radiation enteritis. Furthermore, we did not explore the impact of unhealthy lifestyle habits and age stratification on sarcopenia, which will be our future focus.

4 Methods

4.1 Participants

From 2019 to 2023, the Department of Colorectal Surgery at the Sixth Affiliated Hospital, Sun Yat-sen University treated a total of 62 elderly patients suffering from radiation proctitis. Their ages ranged from 60 to 90 years old, with 58 females and 4 males. The average age of these patients was 68.21 ± 2.52 years. During the same period, a control group of 62 elderly participants who underwent health examinations was selected. Similar to the patient group, the control group also consisted of individuals aged 60–90 years old, with 58 females and 4 males. The average age of the control group was 68.29 ± 2.83 years. Importantly, there were no statistically significant differences in age and gender between the two groups ($P > 0.05$). The diagnosis of radiation enteritis was primarily based on the patient's previous history of cancer, exposure to radiation and chemotherapy, clinical symptoms, and radiological examinations. All patients underwent blood tumor marker testing and pelvic MRI examinations, with some patients being diagnosed with tumor recurrence. In accordance with the 2021 Chinese Expert Consensus on Sarcopenia Diagnosis and Treatment in the Elderly, the diagnostic criteria for sarcopenia were as follows: (1) muscle mass: RSMI < 7 kg/m² for males and < 5.7 kg/m² for females; (2) grip strength: < 28 kg for males and < 18 kg for females; (3) physical function: gait speed < 1.0 m/s, or a short physical performance battery (SPPB) score ≤ 9, or a 5-time sit-to-stand test time ≥ 12 s. According to the inclusion and exclusion criteria, a total of 124 cases were included in this study.

The main diagnosis of radiation enteritis was in accordance with the history of previous tumor, history of radiotherapy, clinical symptoms and imaging examinations. All patients underwent blood tumor marker test and pelvic MRI, and some patients were diagnosed with tumor recurrence.

Inclusion criteria are as follows: (1) age ≥ 60 years; (2) meeting the diagnosis criteria for sarcopenia in radiation enteritis; (3) capable of communicating effectively and move independently.

Exclusion criteria are as follows: (1) presence of metallic devices in the body, such as steel plates or stents; (2) prior limb amputation surgery or inability to establish a connection with the device due to limb issues; (3) coexisting high fever or severe liver or kidney dysfunction; (4) combined with severe depression and other psychiatric disorders; (5) cognitive impairment that hinders communication or cooperation with the examination; (6) individuals in the health check-up group with a diagnosis of malignancy. Informed consent was obtained from all study participants.

4.2 Clinical and laboratory data

General information about all study participants, including gender, age, height, and body weight, was recorded. Clinical data and laboratory indicators for elderly radiation enteritis

patients were also documented, including the time of diagnosis, treatment methods, hemoglobin levels, albumin levels, and prealbumin levels.

4.3 Body composition testing

All participants refrained from eating within 6 hours and avoided bathing, intravenous fluids, and physical activity within 2 hours before the examination. They also emptied their bowels and bladder before the assessment. After measuring height and body weight as routine, the assessment of body composition was conducted using the S10 body composition analyzer from the BIA Biospace company.

The participants lay barefoot on the examination table with their legs spread apart. Electrodes were attached to their heels, and corresponding electrodes were clipped onto their fingers (thumbs and middle fingers for each hand placed in electrode sleeves). Measurement commenced upon inputting their identification number, name, age, height, and gender, and lasted for 2–3 min. Various parameters were recorded, including the subject's protein, fat, and muscle weights, limb muscle mass, lean body mass, body composition, fat percentage, BMI, and upper arm circumference.

4.4 Grip strength and pace Measurement

Grip strength was assessed using a commonly employed standard grip strength dynamometer in clinical practice. Patients were tested in a standing position to evaluate their muscle function. In this study, an EH-101 electronic grip strength dynamometer was used for enrolled patients. Prior to testing, patients were given a demonstration to ensure a clear understanding of how to use the grip strength dynamometer. During measurement, grip distance was adjusted based on individual hand differences, and the tested arm was kept as steady as possible.

Patients were asked to walk for 6 m at their usual walking speed to calculate their pace.

4.5 Statistical methods

The data were analyzed using SPSS 25.0 software. Normally distributed quantitative data were summarized as mean ± standard deviation (SD), and differences between groups were assessed with independent sample t-tests. Count data were expressed as n and %, with group comparisons performed using the chi-squared (χ^2) test. In correlation analysis, Pearson correlation was used for normally distributed data, while Spearman correlation was employed for non-normally distributed data. Binary logistic regression analysis was employed to identify factors influencing the occurrence of sarcopenia among elderly patients with radiation proctitis. Statistical significance was defined as $P < 0.05$.

Ethics approval statement

This study was approved by the Ethics Committee of the Sixth Affiliated Hospital, Sun Yat-sen University (approval number: 2018ZSLYEC-083). Patients were consented by an informed consent process that was reviewed by the Ethics Committee of the Sixth Affiliated Hospital, Sun Yat-sen University and certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

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Author contributions

Tenghui Ma designed the project. Lina Zhang conducted data processing. Wenwen Fu implemented this project and wrote the manuscript.

Conflict of interests

The authors declare no competing interests.

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