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Correlation study and risk assessment of lower back pain and sarcopenia

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Abstract

This study aimed to quantify the lumbar skeletal muscle index (SMI) to predict the incidence and risk of lower back pain and to develop preventive strategies to reduce the incidence of sarcopenia and lower back pain. A total of 29 patients with low back pain in our hospital between September 2022 and March 2024 were enrolled, and lumbar computed tomography data were collected, including age, sex, and visual analog scale (VAS) score for low back pain. This study included 29 patients with an average age of (53.72 ± 18.82) years and an average height of (1.65 ± 0.43) m. The degree of lower back pain was evaluated using the visual analog scoring method, with an average score of (5.14 ± 1.382). Using AutoCAD drawing software, the total cross-sectional area of the skeletal muscles at the level of the lumbar vertebrae was calculated, with an average area of (105.63 ± 27.73) cm^2. The SMI at the level of the lumbar vertebrae 3 was calculated as the ratio of the total cross-sectional area of the skeletal muscles at the level of the lumbar vertebrae to $height^2$, (38.27 ± 8.07). Statistical analysis showed a significant negative correlation ($P < .01$) between SMI, age, and VAS score in patients with sarcopenia, whereas there was no significant difference in SMI between the sexes in patients with sarcopenia($P > .05$). There was a significant negative correlation between SMI and age as well as VAS score, indicating that lower back pain is caused by a decrease in SMI. As people age, their muscle mass and strength gradually decreases.

Abbreviations: CT = computed tomography, L3 = lumbar vertebrae 3, SMI = skeletal muscle index, VAS = visual analog scale.

Keywords: lower back pain, sarcopenia, skeletal muscle index (SMI)

1. Introduction

With an aging population, sarcopenia and low back pain have become common problems affecting the health and quality of life of the elderly. Studies have shown that sarcopenia occurs at a rate of 1% per year after the age of 40.[1] Some scholars have studied the correlation between the paravertebral muscle and age and found that with an increase in age, the area of the paravertebral muscle gradually decreases; that is, the paravertebral muscle gradually atrophied and degenerated.[2] Over 60 years of age, 7.1% to 18.5% of individuals are affected by sarcopenia.[3,4] Low back pain also plagues many older adults, seriously reducing their self-care abilities and activity levels. Sarcopenia leads to a decline in muscle strength and function, increases the risk of falls, and affects balance and physical strength, making daily activities such as walking, sitting, and standing difficult in the elderly population. Lower back pain can cause persistent pain, limit lumbar activity, and affect sleep and mood.[5] These 2 diseases not only affect the quality of life of the elderly, but may also interact to form a vicious circle.

Sarcopenia is a systemic skeletal muscle disease associated with aging that refers to a reduction in muscle mass or strength throughout the body. Its characteristics include a decrease in the number of skeletal muscles and accumulation of fat in the muscle, which leads to a decrease in muscle strength and function. Sarcopenia not only affects the physical strength and balance ability of the elderly but also significantly increases the risk of falls, which is closely related to a higher hospitalization rate, decreased quality of life, and increased risk of death.[6,7]

Low back pain refers to pain or soreness in the area below the waist. It is a general term for a class of diseases with low back pain as the fundamental clinical manifestation; however, it does not include lumbar diseases with other clinical manifestations such as lumbar disc herniation, spinal stenosis, and lumbar spondylolisthesis. The etiology of low back pain is complex and diverse and includes spinal structural damage, degeneration, inflammation, and infection. One of the most

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This study was approved by the Ethics Committee of the 983rd Hospital of the Joint Logistic Support Force.

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common causes of lumbar degeneration is the dysfunction of the lumbar and dorsal muscles, which manifests as decreased muscle strength and endurance. As one of the largest muscle groups in the human body, the lumbar and dorsal muscles play vital roles in maintaining spinal stability and in daily activities.[8-11]

Sarcopenia plays a key role in the occurrence and development of low back pain by affecting the strength and function of lower back muscles. Specifically, a decline in muscle quantity and quality leads to a reduction in the tolerance of muscle tissue around the spine to strain, which easily leads to fatigue and reduces the overall stability of the spine.[12] Spinal instability not only increases the probability of chronic low back pain, but may also cause difficulty in maintaining a normal upright posture and forward leaning, further aggravating the burden on the rear muscles, resulting in further aggravation of symptoms. Persistence of low back pain also exacerbates sarcopenia. Long-term pain causes patients to have limited activities, reduces the number of daily activities and exercise, and accelerates disuse muscle atrophy. Pain may also affect appetite and nutrient intake, further aggravating muscle loss.

The assessment of sarcopenia at home and abroad is based on the skeletal muscle mass of limbs.[8] Currently, there is no unified standard or quantitative index for diagnosing sarcopenia by using computed tomography (CT). The literature shows that Sarcopenia can be assessed by measuring the skeletal muscle index (SMI) at the level of the lumbar vertebrae 3 (L3), that is, the total cross-sectional area of skeletal muscle at the level of the L3/height^2.[13-16] In this study, CT was used to quantitatively evaluate the distribution of skeletal muscle components and adipose tissue in different regions of the body and individual muscle groups by scanning the cross-section of the L3 and using special software measurement tools.[17,18] The correlation between the 2 was analyzed according to the CT measurement of the SMI at the level of L3 and the visual analog scale (VAS) of patients with low back pain to assess the degree of pain. Through correlation analysis, the relationship between the SMI of sarcopenia and the VAS score for low back pain and age was quantified, and the lumbar SMI of sarcopenia was quantified to predict the incidence and risk of low back pain to formulate prevention strategies and reduce the incidence of sarcopenia and low back pain. The early detection and intervention of acute and chronic diseases caused by sarcopenia have important clinical significance.

2. Materials and methods

2.1. Inclusion criteria

Data from 29 patients with low back pain in our hospital from September 2022 to March 2024 were collected and analyzed, and a CT examination of the lumbar spine was performed. The inclusion criteria were as follows: adults aged ≥ 18 years with chronic low back pain (>3 months); exclusion of low back pain caused by lumbar surgery, severe lumbar disc herniation, lumbar spinal stenosis, and spinal fracture; and lumbar spine CT scan performed, and the psoas major and paravertebral muscles measured at the middle level of the L3.

2.2. Data measurement

CT data of the lumbar spine were collected, along with age, sex, and VAS score for low back pain.

In this study, we measured the SMI at the L3, that is, the total cross-sectional area of the skeletal muscle at the L3/height^2. Based on the CT images of the L3, the total cross-sectional areas of the psoas major and paravertebral muscles were calculated using the AutoCAD drawing software (Fig. 1). The degree of low back pain was evaluated using VAS.

Data analysis was performed using SPSS software (version 21.0, IBM SPSS statistics) for data processing. A *t*-test was used to collect data, and the correlation between the muscle index and age, sex, and VAS score was analyzed. The inspection level (α) is set to 0.01.

Twenty-nine patients were included, including 12 males and 17 females, with an average age of (53.72 ± 18.82) years and an average height of (1.65 ± 0.43) m. The degree of low back pain was assessed using a VAS, and the average score was (5.14 ± 1.382). AutoCAD drawing software was used to calculate the total cross-sectional area of skeletal muscle at the level of the L3; the average area was (105.63 ± 27.73) cm^2, and the SMI at the level of the L3, which was the total cross-sectional area of skeletal muscle at the level of the L3/height^2, was (38.27 ± 8.07).

3. Result

In this study, we found a significant association between sarcopenia-related SMI at the L3 level and VAS score, as well as age in low back pain patients. From Tables 1 and 2, there was a significant negative correlation between SMI, age, and VAS score in patients with sarcopenia ($P < .01$). From Table 3, there was no significant difference in SMI between sexes in patients with sarcopenia ($P > .05$).

Age is an important risk factor of sarcopenia. SMI decreased significantly with increasing age. Second, there was a significant negative correlation between the SMI and VAS score in patients with sarcopenia. The decrease in SMI may reflect atrophy and weakening of the lumbar muscles, and the increase in VAS score may reflect a decrease in SMI in patients with low back pain. Third, the SMI of patients with sarcopenia was not significantly different between sexes.

4. Discussion

Lower back pain is a common health problem in the elderly and is closely associated with a decline in skeletal muscle mass. The skeletal muscle is not only the main executor of exercise, but also provides protection for the spine and other joints through

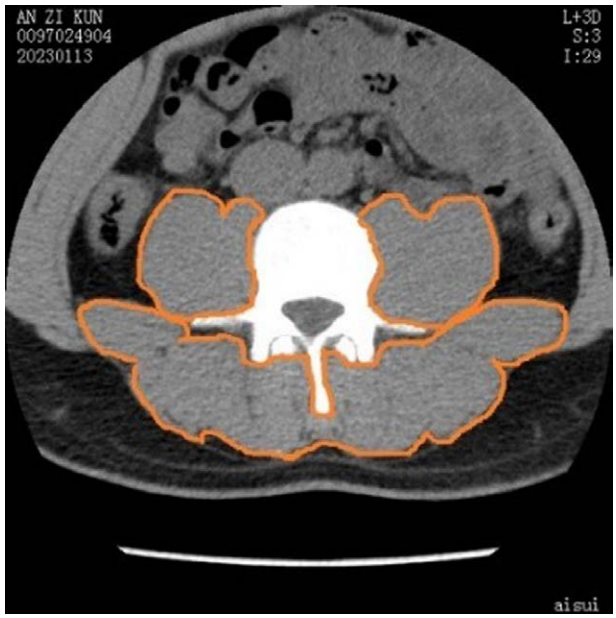

Figure 1. Twenty-three years male, the CT images of the lumbar vertebrae 3 (L3), the total cross-sectional areas of the psoas major and paravertebral muscles. CT = computed tomography.

its stability and support. When the mass and strength of skeletal muscles decline, the stability of the spine, and joints is affected, which can lead to pain and other discomfort symptoms. Sarcopenia can have a serious impact on spinal health and lead to spinal instability. Owing to the decline in muscle quantity and quality, muscle tolerance to strain is significantly reduced and it is more prone to fatigue, which makes it difficult to maintain the overall stability of the spine. This greatly increases the incidence of chronic low back pain. At the same time, the decline in trunk muscles, especially the back extensor muscles, makes them more prone to fatigue, which seriously affects the quality of life of patients.[19-21] Therefore, the statistically significant decline in SMI in patients with low back pain actually reflects a causal relationship between the decline in skeletal muscle mass and pain.

Sarcopenia is a disease closely related to age. With increasing age, the muscle mass and strength of the human body gradually decline, which is part of the natural aging process. However, the incidence of sarcopenia is significantly higher in the elderly, which may be related to several factors.

Intermuscular fat infiltration is an important pathological feature of sarcopenia, which refers to the abnormal deposition of adipocytes in muscle tissue.[22-24] This fatty infiltration not only reduces effective muscle mass but also affects muscle function through a series of complex biological mechanisms. Specifically, fat infiltration may affect muscles in several ways: reduced muscle mass: The infiltration of fat in muscle tissue occupies the space of muscle fibers, resulting in a reduction in the number and diameter of muscle fibers, which then affects the contraction strength and endurance of the muscle; damage to muscle function: A variety of adipokines and inflammatory mediators secreted by adipocytes may interfere with the normal physiological function of muscle cells, resulting in decreased muscle contractility, muscle pain, and movement disorders, thereby affecting the quality of daily life of patients; promote sarcopenia: Fat infiltration may further promote sarcopenia by affecting muscle metabolism and signaling pathways.

With increasing age, the physiological functions of the human body gradually undergo degenerative changes and skeletal muscles are no exception. Skeletal muscle is attached to the bone, which is essential for maintaining body posture and completing daily activities and motor functions. Studies have shown that the quality and strength of skeletal muscle in the elderly gradually decline due to a variety of factors (such as hormone changes, decreased nutrient absorption capacity, reduced exercise, etc), which is the so-called "sarcopenia." This change was statistically represented by a significant decline in SMI with age.

There was little difference in incidence between men and women. First, this may be related to the gradual improvement in the current living standards in China, obvious changes in lifestyles, and the decline in the overall actual activity of older people. Second, sarcopenia can be affected by several factors. For high-risk individuals, such as the elderly, those with chronic diseases, and long-term bedridden individuals, the incidence of sarcopenia is higher than that in the general population. Third, there were few elderly patients with simple low back pain.

Therefore, early identification of the risk factors for sarcopenia through scientific and reasonable treatment and intervention measures can effectively delay the progression of sarcopenia.[25,26] This is the key to preventing and delaying the occurrence and development of sarcopenia, curbing the occurrence and progression of sarcopenia in the elderly, improving the quality of life of the elderly, and improving the quality of life of the elderly. Further in-depth research on the pathogenesis of sarcopenia is needed, and more effective treatment methods and intervention strategies are being developed to reduce the burden on the elderly, families, and society; promote the construction of a healthy aging society; and protect the health of the elderly.

Sarcopenia not only affects the overall function and quality of life of patients, but is also closely related to the occurrence and development of lumbar degenerative disease. Sarcopenia should not be ignored in the diagnosis and treatment of degenerative spinal disease. First, in the preoperative evaluation stage, potential high-risk patients were identified by measuring the lumbar paravertebral muscle index and other methods, and personalized surgical and rehabilitation plans were formulated according to the muscle mass and strength status. Second, during surgical treatment, injury and destruction of the paravertebral muscles should be minimized to protect muscle function. In addition, rehabilitation training should be initiated as soon as possible after surgery, focusing on strengthening muscle strength and balance training to promote the recovery of patients and reduce the occurrence of complications. Therefore, attention should be paid to the evaluation and management of sarcopenia as an important part of the diagnosis and treatment of degenerative spinal diseases. We can effectively reduce the incidence of postoperative complications and improve the quality of prognosis in patients with spinal degenerative disease by preoperative measurement of the lumbar paravertebral muscle index and development of personalized intervention strategies.[27-29] At the same time, our study had certain limitations. Further follow-up is needed to expand the sample size and conduct supplementary research on the influence of sex. We should continue to pay attention to research progress and technological innovation in this field to promote continuous improvement in the diagnosis and treatment of spinal degenerative diseases.

In conclusion, the significant correlation among SMI, age, and VAS score in patients with sarcopenia suggests that these factors should be comprehensively considered for the prevention and treatment of sarcopenia. Reasonable dietary adjustment, increased exercise, improved lifestyle, and necessary medical interventions (such as physical therapy and drug therapy) can effectively delay the decline in skeletal muscle mass, reduce pain symptoms, and improve the quality of life of patients.[30,31]

Table 1

Sample size of statistical data.

Variable	Statistics (mean, standard deviation)	*P* value
Gender	12/17	<.01
Age	53.72 ± 18.82	<.01
Height	1.65 ± 0.43	<.01
VAS score	5.14 ± 1.382	<.01
Muscle area (cm^2)	105.63 ± 27.73	<.01
SMI	38.27 ± 8.07	<.01

Significant correlation at the 0.01 level (2-sided).
SMI = skeletal muscle index, VAS = visual analog scale.

Table 2

Correlation analysis.

		Age	VAS score
SMI	Pearson correlation	−0.69*	−0.834*
	Significance (bilateral)	0.00	0.00
	N	29	29

SMI = skeletal muscle index, VAS = visual analog scale.
*Significant correlation at the 0.01 level (2-sided).

Table 3

Relationship between different genders.

Variable	Male (12/29)	Female (17/29)	*P* value
SMI	43.54 ± 7.98	34.55 ± 5.88	.098

SMI = skeletal muscle index.

Author contributions

Data curation: Chunlei Wu.
Funding acquisition: Lei Xiao.
Resources: Qiong Wei.
Supervision: Hao Wang.
Writing – original draft: Wen Hu.

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