Influence of Sarcopenia on the Effect of Exercise Therapy for Elderly Patients with Chronic Low Back Pain

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Abstract:

Introduction: Sarcopenia, a condition characterized by decreased skeletal muscle mass, has increasingly been attracting attention in Japan, which has an aged society. The association between chronic low back pain (CLBP) and muscle mass is important. This study aimed to investigate the effect of exercise therapy for CLBP with or without sarcopenia.

Methods: This study was a prospective cohort study. Patients who were aged >65 years during 2017-2018 and had CLBP, with pain lasting >12 weeks and pain intensity being ≥3, were included in the study. The patients were divided into two groups: sarcopenia (S) and nonsarcopenia (NS) groups. The numerical rating scale (NRS) for pain intensity, Roland-Morris Disability Questionnaire (RMDQ), Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ), Hospital Anxiety and Depression Scale (HADS), trunk muscle strength, a European Quality of Life instrument, and an NRS of treatment satisfaction were assessed. All patients underwent a high-intensity exercise therapy during 2 weeks of hospitalization and were followed up for 1 and 3 months.

Results: Twenty-eight patients with CLBP were included. The prevalence rate of sarcopenia was 42.9%. The NRS and RMDQ scores and gait function were clinically improved at the end points in all patients with or without sarcopenia. Moreover, high treatment satisfaction was achieved. The quality of life, treatment satisfaction, psychological disorder subscale score of the JOABPEQ, and HADS score tended to be lower in the S group than in the NS group.

Conclusions: Our short-term exercise therapy was effective for low back pain, disability, and gait disturbance in elderly patients with CLBP with or without sarcopenia. However, the prevalence of sarcopenia was high in elderly patients with CLBP. Although low back pain and disability in patients in the S group were improved by exercise therapy, their quality of life and treatment satisfaction might be lower than those of patients without sarcopenia.

Keywords:
sarcopenia, chronic low back pain, physical therapy, quality of life, exercise
such as physical disability, poor quality of life and death". In Japan, where 27.7% of the population are aged >65 years, sarcopenia is becoming a concern. Reports on the relationship between LBP and the muscles have indicated that LBP is related to lumbar extensor and multifidus muscle atrophy, the recurrence rate of LBP is related to impaired spinal stability due to muscle loss, and LBP is associated with the intramuscular fat of spinal extensors. Although the causal relationship is not clear, it has been shown that muscles and LBP are related. An effective treatment strategy for chronic LBP (CLBP) is exercise therapy. However, the effect of exercise therapy for patients with CLBP and sarcopenia, which decreases musculoskeletal muscle mass, is unclear. We hypothesized that exercise therapy is effective for patients with CLBP and sarcopenia. This study aimed to investigate the outcomes of short-term exercise therapy for patients with CLBP with or without sarcopenia.

Materials and Methods

This was a prospective cohort study. The participants included patients with CLBP who were diagnosed to have no specific disease causing back pain (BP) by an orthopedic spine surgeon certified by the Japanese Orthopaedic Association and the Japanese Society for Spine Surgery and Related Research. They were admitted to our center and administered conservative therapy, mainly including exercise therapy. Our study protocol consisted of 2 weeks of short-term hospitalization, which included exercise therapy and pharmacotherapy. After discharge, the patients were instructed to continue the exercise, which was performed under supervision by a physical therapist during their hospital stay. Additionally, they were also checked for exercise positions and adherence to the exercise schedule once a week for 3 months at our center (Fig. 1). For pharmacotherapy, only nonsteroidal anti-inflammatory drugs (NSAIDs) were used as needed, but not epidural steroid injections, duloxetine, acetaminophen, and opioids.

Participants

Consecutive patients with CLBP aged >65 years who were hospitalized and treated from September 2017 to November 2018 were included in this study. At outpatient visits, these patients were confirmed not to have any specific diseases through radiography and magnetic resonance imaging. For inclusion criteria, LBP was defined as pain from the lowest rib to the gluteal fold and CLBP as pain that lasted for ≥12 weeks. The inclusion criteria were CLBP, pain intensity > 3 on the numerical rating scale (NRS), non-receipt of exercise therapy at any other hospital or clinic, and inability to work due to BP. The exclusion criteria were acute LBP, lower extremity osteoarthritis that required treatment, having undergone surgical treatment, neurological complications, dementia, having extended leave due to a disease, or getting insurance as a result of an accident. This study has been approved by the Institutional Review Board of our affiliated institution. All patients provided their written informed consent prior to participation, and those who met the inclusion criteria and provided consent were consecutively enrolled in this study.

Intervention

All patients underwent an exercise program supervised by a physical therapist. The program included trunk muscle training, especially the transversus abdominis and multifidus muscles; stretching; stationary cycling; and other exercise therapies tailored to individual conditions, such as lower limb muscle strength training, joint mobilization, and guidance of posture and movement that does not overbend and add stress on the lumbar area. Aerobic exercise was performed for >15 min with appropriate loads. The patients underwent two sessions of exercise therapy daily (each session lasting 40-60 min), five to six times a week during 2 weeks of hospitalization. After discharge, they were instructed to continue the exercise that they performed during their hospitalization. Pain control was individualized using NSAIDs.

Outcome assessments

Demographic characteristics, including age, sex, body height, body weight, body mass index (BMI), skeletal muscle index (SMI), and LBP duration, were recorded. The primary outcome measure was BP intensity measured using the NRS and Vestibular Disorders Activities of Daily Living Scale score for LBP measured using the Roland-Morris Disability Questionnaire (RMDQ). The NRS scores range from 0 (no pain) to 10 (worst pain imaginable). The RMDQ measures patient-reported outcomes and consists of 24 items, which evaluate the degree to which daily life is impaired by BP. The score ranges from 0 (no disability) to 24 (maximum disability), depending on the questionnaire. The NRS and RMDQ determine the clinical efficacy of an intervention using minimal clinically important difference (MCID). Jaeschke et al. defined MCID as the “smallest difference in score in the domain of interest, which patients perceive as beneficial and which would mandate, in the absence of troublesome side effects and excessive cost, a change in the patient’s management”. Previously, a reduction of 2 points in the NRS score and 30% in the RMDQ score represented the MCID for patients.

The secondary outcomes were the results of the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ), the Hospital Anxiety and Depression Scale (HADS), the trunk muscle strength test, the 5-level version of the EuroQol 5-dimension (EQ-5D-5L) instrument, and the NRS of treatment satisfaction. The JOABPEQ is a multifactorial evaluation questionnaire and consists of five domains: pain-related disorder, lumbar spine dysfunction, gait disturbance, social life dysfunction, and psychological disorder. The range of the score for each of its subscales is from 0 to 100, with higher scores indicating better condition, and if the score increases by ≥20 points or improves from <90 points to ≥90 points, the treatment is judged as ef-
Figure 1. Flow diagram. NRS: Numerical rating scale; LBP: Low back pain; SMI: Skeletal muscle index; S group: Sarcopenia group; NS group: Nonsarcopenia group

Additional effective. Additionally, an increase of 20 points in each domain of the JOABPEQ represented an MCID for the patient[23]. The SMI was measured by bioelectrical impedance analysis using a body composition meter (InBody S10; InBody, Tokyo, Japan). Patients were evaluated after 10 min in the supine position. Isokinetic trunk muscle strength (i.e., trunk flexor and spinal extensor) was measured using Biodex System 4 (Biodex Medical Systems, Shirley, NY, USA) at an angular velocity of 60°. For standardization, the obtained torque (Nm) was calculated as a percentage by dividing by the body weight (kg). The satisfaction of treatment was evaluated using NRS scores from 0 (unsatisfied) to 10 (very satisfied). Each datum was measured at baseline, 2 weeks after admission (at discharge), and at 1- and 3-month follow-ups. All patients responded to all the questionnaires alone in a quiet room. The assessors were blinded to
the patient groups. We also minimized bias by having a blinded and independent physical therapist perform all the baseline examinations and follow-up reexaminations.

**Statistical analysis**

All analyses were conducted using the JMP software (v. 14; SAS Institute, Cary, NC, USA). Participants with sarcopenia were identified using the definition of Asian Working Group for Sarcopenia, in which the SMI < 7.0 kg/m² in men and <5.7 kg/m² in women. All patients were divided into sarcopenia (S) and nonsarcopenia (NS) groups. To estimate the group differences in response to treatment at both time points, a liner mixed model analysis was conducted with an unstructured covariance. The model included treatment, time, and treatment × time interaction as fixed effects. The nominal scale was analyzed using the chi-squared test, but it did not require age and sex to be included in the final models. The missing data were processed using the last-observation-carried-forward method. Two-sided P < 0.05 was considered statistically significant.

**Results**

Twenty-eight patients were included in this prospective study. The mean patient age was 70.7 ± 9.8 years, body height 155.2 ± 9.8 cm, body weight 55.0 ± 12.4 kg, BMI 22.7 ± 3.5 kg/m², SMI 6.4 ± 1.1 kg/m², and pain duration 117.9 ± 125.2 months; 71.4% of the patients were women. The patients’ baseline characteristics are presented in Table 1. All patients were divided into two groups based on the SMI: S (n = 12) and NS (n = 16) groups. The prevalence rate of sarcopenia was 42.9%. Body height (150.1 ± 7.6 cm vs 159.0 ± 9.8 cm; P < 0.05), body weight (47.2 ± 4.8 kg vs 60.9 ± 13.2 kg; P < 0.01), BMI (21.0 ± 2.0 kg/m² vs 23.9 ± 3.9 kg/m², P < 0.05), and SMI (5.6 ± 0.5 kg/m² vs 7.0 ± 1.1 kg/m², P < 0.001) in the S group were significantly lower than those in the NS group, but age (74.7 ± 9.7 years vs 67.7 ± 9.1 years, P = 0.06), proportion of women (83.3% vs 62.5%, P = 0.23), and pain duration (117.9 ± 125.2 months vs 129.8 ± 126.0 months, P = 0.57) were not significantly different. At baseline, there were no significant differences in the JOABPEQ domains (pain-related disorder: 58.3 ± 39.7 vs 39.2 ± 30.2, P = 0.19; lumbar spine dysfunction: 76.4 ± 15.4 vs 59.4 ± 29.3, P = 0.18; gait disturbance: 44.6 ± 21.8 vs 37.5 ± 24.4, P = 0.44; social life dysfunction: 46.4 ± 15.1 vs 42.4 ± 13.0, P = 0.17; and psychological disorder: 48.1 ± 16.2 vs 43.6 ± 13.8, P = 0.38). In the NRS for BP, there was no significant difference between the two groups upon follow-up, but both groups exhibited an improvement greater than the MCID at discharge and maintained this improvement until the 3-month follow-up (Table 2). Similarly, in the RMDQ results, there was no significant difference between the groups at baseline, but both groups exhibited an improvement greater than the MCID at discharge and follow-up. Only the NS group exhibited a statistically significant improvement from baseline to the 3-month follow-up (Table 2). Regarding the JOABPEQ subscales, psychological disorder and lumbar spine dysfunction exhibited lower scores in the S group than in the NS group at the 3-month follow-up (14.1 ± 3.9 in the NS group, 3.3 ± 4.5 in the S group, P < 0.1), and pain-related disorder and gait disturbance exhibited scores over 20 points higher (Fig. 2). There was no statistically significant difference in the other subscales, e.g., most of the subscales tended to exhibit lower scores in the S group than in the NS group (Table 2). As for the HADS, both anxiety and depression were improved at discharge in the NS group, whereas in the S group, there was no significant improvement. The trunk flexor strength of the NS group was statistically increased at the 1- and 3-month follow-ups, whereas in the S group, the trunk flexor and extensor strengths were increased at each time point, but were not statistically different. Additionally, there were no differences in the trunk flexor and extensor strengths at each time point between the groups. For the EQ-5D-5L, the ratio of the number of patients who exhibited a changed score that exceeded 0.03 in the S group was lower than that

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**Table 1.** Demographic and Baseline Characteristics of Participants with Chronic Low Back Pain.

|                          | All          | NS group   | S group    | P value |
|--------------------------|--------------|------------|------------|---------|
| No. of patients          | 28           | 16         | 12         |         |
| Age, years               | 70.7 (9.8)   | 67.7 (9.1) | 74.7 (9.7) | 0.06*   |
| %Female, %               | 71.4         | 62.5       | 83.3       | 0.23*   |
| Body height, cm          | 155.2 (9.8)  | 159.0 (9.8) | 150.1 (7.6) | <0.05* |
| Body weight, kg          | 55.0 (12.4)  | 60.9 (13.2) | 47.2 (4.8) | <0.01* |
| BMI, kg/m²               | 22.7 (3.5)   | 23.9 (3.9)  | 21.0 (2.0)  | <0.05* |
| SMI, kg/m²               | 6.4 (1.1)    | 7.0 (1.1)   | 5.6 (0.5)   | <0.001* |
| Pain duration, month     | 117.9 (125.2)| 129.8 (126.0)| 101.9 (127.9) | 0.57*   |
| Prevalence of a sarcopenia, % | 42.9         |            |            |         |

Abbreviation: NS, non-sarcopenia; S, sarcopenia; BMI, body mass index; SMI, skeletal muscle index

Value are means (standard deviation), a) non-paired t-test, b) Fisher’s exact test
Table 2. Primary and Secondary Outcomes.

|                  | NS group | S group | Mean Effect of Time | Interaction Effect |
|------------------|----------|---------|---------------------|--------------------|
|                  | Least Squares Means (SE) | Within Group Difference, Least Squares Means (95% CI) | Least Squares Means (SE) | Within Group Difference, Least Squares Means (95% CI) | F Score | P | F Score | P |
| Primary outcome measure |          |         |                     |                    |        |   |        |   |
| NRS score (of 10) |          |         |                     |                    |        |   |        |   |
| Baseline         | 5.125 (0.448) | NA | 5.917 (0.518) | NA | -0.792 |         |        |        |   |
| 2-week           | 2.281 (0.448) | -2.844 | 2.080 (0.518) | -3.708 | (2.924 to 1.341) | 29.018 | <.0001 | 0.547 | .65 |
| 1-month          | 2.594 (0.448) | -3.117 to -0.946 | 2.542 (0.518) | -5.206 to -1.545 | (2.081 to 2.184) |        |   |        |   |
| 3-month          | 3.000 (0.448) | -2.125 | 3.333 (0.518) | -4.414 to -0.753 | (2.466 to 1.800) |        |   |        |   |
| RMDQ score       |          |         |                     |                    |        |   |        |   |
| Baseline         | 10.750 (1.176) | NA | 8.500 (1.358) | NA | 2.250 |         |        |        |   |
| 2-week           | 6.250 (1.176) | -4.500 | 5.750 (1.358) | -2.750 | -3.347 to 7.847 | 14.242 | <.0001 | 0.851 | .47 |
| 1-month          | 6.875 (1.176) | -3.875 | 4.333 (1.358) | -4.167 | 0.500 |         |        |        |   |
| 3-month          | 7.125 (1.176) | -6.451 to -0.799 | 5.500 (1.358) | -6.263 to 0.263 | (-3.972 to 7.222) |        |   |        |   |
| Secondary outcome measure |          |         |                     |                    |        |   |        |   |
| HADS Anxiety     |          |         |                     |                    |        |   |        |   |
| Baseline         | 5.313 (0.832) | NA | 5.500 (0.961) | NA | -0.188 |         |        |        |   |
| 2-week           | 2.625 (0.832) | -2.688 | 4.750 (1.358) | -0.750 | (3.138 to 7.722) | 4.314 | .0072 | 1.762 | .16 |
| 1-month          | 3.563 (0.832) | -1.750 | 4.000 (1.358) | -1.467 | (1.397 to 3.522) | 7.964 | .0001 | 0.964 | .41 |
| 3-month          | 3.188 (0.832) | -4.322 to 0.007 | 5.167 (0.961) | -2.870 to 2.203 | (-5.939 to 1.980) |        |   |        |   |
| HADS Depression  |          |         |                     |                    |        |   |        |   |
| Baseline         | 5.688 (0.791) | NA | 6.417 (0.914) | NA | -0.729 |         |        |        |   |
| 2-week           | 3.000 (0.791) | -2.688 | 5.000 (0.914) | -1.417 | (4.495 to 3.036) | 7.964 | .0001 | 0.964 | .41 |
| 1-month          | 4.000 (0.791) | -3.556 to 0.181 | 4.830 (0.914) | -1.333 | (5.765 to 1.765) | 3.210 | .03 | 0.295 | .83 |
| 3-month          | 4.000 (0.791) | -3.556 to 0.181 | 5.083 (0.914) | -1.333 | (4.849 to 2.682) | 3.210 | .03 | 0.295 | .83 |
| Trunk extensor strength, Nm/kg×10^2 |          |         |                     |                    |        |   |        |   |
| Baseline         | 132.166 (19.373) | NA | 112.093 (22.491) | NA | 20.072 |         |        |        |   |
| 2-week           | 181.678 (19.373) | -34.861 to 133.886 | 145.260 (22.491) | -64.200 to 130.593 | (-55.449 to 128.285) | 3.210 | .03 | 0.295 | .83 |
| 1-month          | 196.159 (19.373) | -20.380 to 148.367 | 150.860 (22.491) | -58.660 to 130.193 | (-46.568 to 137.166) |        |   |        |   |
| 3-month          | 210.478 (19.373) | -6.061 to 162.668 | 152.360 (22.491) | -57.160 to 137.693 | (-33.749 to 149.985) |        |   |        |   |
in the NS group. However, there was no significant difference between the groups in the proportion of patients exhibiting an improvement in the EQ-5D-5L results over the follow-up period. The treatment satisfaction in the S group increased by 0.03 from baseline over all follow-up periods, which was not significantly different. The QoL score of the S group was lower by 0.03 than that of the NS group over the follow-up periods, and it was not significantly different. The QoL of the S group did not exhibit a significant chronological change, which was lower than that of the NS group for all follow-up periods, and it was not significantly different. The QoL of the NS group increased by 0.03 points from baseline to the follow-up periods, which was not significantly different. The QoL of the NS group was lower by 0.03 than that of the NS group for all follow-up periods, and it was not significantly different.

### Discussion

This study investigated whether sarcopenia influences the therapeutic effect of 2 weeks of hospitalization and high-intensity exercise therapy for elderly patients with CLBP. This short-term high-intensity exercise therapy improved BP and disability, including gait disturbance, in patients with or without sarcopenia. Therefore, exercise therapy was effective for elderly patients with CLBP. Additionally, the treatment satisfaction was high, and there were no patient dropouts; thus, the follow-up ratio in this study was 100%.

The prevalence rate of sarcopenia was 42.9% in our study. Previous studies reported the prevalence rate of sarcopenia as 16%-24% for lumbar spinal stenosis, 46.6% for lumbar degenerative scoliosis, 43.3% for cervical myelopathy, and 25%-35.5% for LBP. Our study had a higher prevalence of sarcopenia than reported previously.

Our results are in line with a previous report on the effect of exercise. Exercise therapy can contribute to the improvement of LBP and disability by maintaining activity and enhancing physical function despite the presence of sarcopenia. Therefore, regarding the therapeutic effects of our study, exercise therapy was shown to be effective because BP and disability were improved regardless of sarcopenia. The QoL of the NS group increased by 0.03 points from baseline to the follow-up periods, which was not significantly different. The QoL of the S group did not exhibit a significant chronological change, which was lower than that of the NS group by 0.03. The MCID in the EQ-5D-5L was reported as 0.03; thus, patients with CLBP...
The obtained scores of the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) subscales from baseline to follow-up. The JOABPEQ consists of five domains: pain-related disorder (a), lumbar spine dysfunction (b), gait disturbance (c), social life dysfunction (d), and psychological disorder (e). A significant difference in psychological disorder was found between the two groups at the 1-month follow-up. Psychological disorder and lumbar spine dysfunction exhibited lower scores in the S group than in the NS group at the 3-month follow-up, and pain-related dysfunction and gait disturbance exhibited scores over 20 points higher. † indicates P<0.1. * indicates P<0.05. Data are expressed as mean±standard error.
treatment satisfaction may be lower than those of patients without sarcopenia. To improve these parameters, it will be necessary to examine an aerobic exercise program that is adjusted for exercise intensity and dose.

**Disclaimer:** Mamoru Kawakami is one of the Editors of Spine Surgery and Related Research and on the journal’s Editorial Committee. He was not involved in the editorial evaluation or decision to accept this article for publication at all.

**Conflicts of Interest:** The authors declare that there are no relevant conflicts of interest.

**Author Contributions:** MN drafted the manuscript. MN and MM performed the statistical analysis. MN, MK, and MM contributed to the analysis and interpretation of the results. All authors have read, reviewed, and approved the manuscript.

**Informed Consent:** Informed consent was obtained from all participants in this study.

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