

Population-based study of the association of osteoporosis and chronic musculoskeletal pain and locomotive syndrome: the Katashina study

Yoichi Iizuka¹ · Haku Iizuka¹ · Tokue Mieda¹ · Tsuyoshi Tajika¹ · Atsushi Yamamoto¹ · Kenji Takagishi¹

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Abstract

Background “Locomotive syndrome”, a concept proposed by the Japanese Orthopaedic Association (JOA), refers to risk conditions among the elderly population that may lead to the need for nursing care services. The association between osteoporosis (OP) or chronic musculoskeletal pain (CMSP) and the screening results of locomotive dysfunction identified by the GLFS-25 (a 25-question geriatric locomotive function scale) has not yet been adequately investigated.

Materials and Methods Two hundred eighty-seven Japanese subjects were evaluated for locomotive dysfunction using the GLFS-25 and were also evaluated for their bone status by a quantitative ultrasound (QUS) assessment of the bone status (i.e., the measurement of the speed of sound (SOS) of the calcaneus). Furthermore, a questionnaire survey concerning CMSP persisting for 3 months or longer was given to those subjects. Statistical analyses were conducted to clarify the association between the bone status or CMSP and the screening results for locomotive dysfunction.

Results The % young adult mean (%YAM) of the SOS was significantly lower among the 43 subjects with locomotive dysfunction identified by the GLFS-25 than in the 244 subjects without locomotive dysfunction ($p < 0.001$). Moreover, low back pain ($p < 0.01$), shoulder pain ($p < 0.05$) and knee pain ($p < 0.001$) were significantly more frequently observed in the 43 subjects with locomotive dysfunction

than the 244 subjects without locomotive dysfunction. The screening results of the %YAM of the SOS was significantly associated with the population demonstrating locomotive dysfunction screened by the GLFS-25 based on the age-, gender- and BMI-adjusted analysis (OR 0.95, 95 % CI 0.91–0.98). Furthermore, the %YAM of SOS correlated with the GLFS-25 score ($\beta = -0.212$, $p = 0.001$). Furthermore, low back pain (OR 2.60, 95 % CI 1.29–5.24), shoulder pain (OR 2.16, 95 % CI 1.00–4.66), and knee pain (OR 2.97, 95 % CI 1.41–6.28) were found to be associated with locomotive dysfunction based on the results of the age-, gender- and a BMI-adjusted analysis.

Conclusions The %YAM of the SOS was associated with the population demonstrating locomotive dysfunction which was identified using the GLFS-25, and the severity of locomotive dysfunction evaluated by the GLFS-25 was found to correlate with the %YAM of the SOS. Furthermore, low back pain, shoulder pain and knee pain were found to be associated with the screening results for locomotive dysfunction by the GLFS-25.

Introduction

“Locomotive syndrome”, a concept regarding locomotive dysfunction proposed by the Japanese Orthopaedic Association (JOA), refers to risk conditions among the elderly population, including muscle weakness, joint or spine disorders and osteoporosis (OP) that may lead to the need for nursing services [1–3].

The elderly population has been rapidly increasing in Japan in recent years, and the number of patients with OP and osteoarthritis (OA) is increasing [4]. Importantly, the contraction and progression of such diseases are known to often lead to locomotive dysfunction [5–8]. Therefore,

✉ Tokue Mieda
tmieda@gunma-u.ac.jp

¹ Department of Orthopaedic Surgery, Gunma University Graduate School of Medicine, 3-39-22, Showa, Maebashi, Gunma 371-8511, Japan

epidemiologic studies investigating the possible causative relationships between these factors are awaited. Additionally, because musculoskeletal diseases are usually associated with chronic musculoskeletal pain (CMSP) [9–13], which is a common symptom in Japan [13–16] and results in a decreased quality of life (QOL) [17–24], the contribution of these conditions to locomotive function should also be investigated.

Regarding the evaluation tools for assessing locomotive dysfunction, Seichi et al. developed the GLFS-25, a 25-question geriatric locomotive function scale, and demonstrated that the GLFS-25 is a valid and reliable questionnaire scale for detecting the population with locomotive dysfunction in elderly Japanese individuals [25].

The aim of the present study was to clarify the associations between OP or CMSP and the population with locomotive dysfunction identified by the use of the GLFS-25 in the Japanese general population.

Materials and methods

In a mountain village located in the northern area of Gunma prefecture in Japan (Katashina village, population 4465 in 2014), local medical examinations for the general population have been held annually to screen for life-related diseases. The total number of subjects examined in 2013 was 1037. (1) A total of 581 individuals participated in musculoskeletal examinations and provided written informed consent. Of these subjects, (2) 416 of the 581 individuals underwent screening for locomotive dysfunction using the GLFS-25, (3) 317 of 416 individuals underwent a quantitative ultrasound (QUS) assessment of the bone status and speed of sound (SOS) of the calcaneus using a CM-200 densitometer (Furuno Electric, Nishinomiya City, Japan) [26], (4) 311 of 317 individuals completed a questionnaire regarding CMSP, (5) demographic variables and body mass index (BMI) data were recorded for 298 of 311 individuals and (6) 287 of 298 individuals were 40 years of age or older. Therefore, in this study, a total of 287 subjects (100 males and 187 females, average age 64.7 years, range 40–89 years) who satisfied all of the above categories were included in this study.

We divided the subjects into two populations based on the GLFS-25 score, the population with locomotive dysfunction and the population without locomotive dysfunction; specifically, if the GLFS-25 score was 16 or greater, the subjects were assigned to the population with locomotive dysfunction, and if the score was 15 or less, the subjects were assigned to the population without locomotive dysfunction [25]. The current cutoff score for identifying a population with locomotive dysfunction was determined to be 16 based on a receiver-operating characteristic curve

analysis in that study [25]. Furthermore, a questionnaire concerning CMSP (neck pain, back pain, low back pain, shoulder pain, elbow or wrist pain, hip pain and knee pain) persisting for three months or longer [27], was given during the musculoskeletal examinations.

The associations between the bone status and the CMSP and GLFS-25 scores were statistically investigated.

This study was approved by the institutional review board of Gunma University.

Statistical analyses

Univariate analyses were performed using Welch's *t* test, the Chi square test, and Fisher's exact probability test. As important confounding factors for the bone status and CMSP, age, gender and BMI were considered in the logistic regression and multiple regression analyses, referring to previous papers [13, 15, 28–30], even if these parameters were not associated with locomotive dysfunction in the univariate analyses. A *p*-value of 0.05 was considered to be statistically significant. All statistical analyses were conducted using the IBM SPSS Statistics 19 software package (IBM Japan, Tokyo, Japan).

Results

Forty-three of the 287 (15.0 %) subjects were classified as belonging to the population with locomotive dysfunction based on the results of the GLFS-25 scores.

Table 1 shows the association between locomotive dysfunction screened by the GLFS-25 scores and age, gender, BMI, chronic musculoskeletal pain and bone status. According to an univariate analysis, the mean subject age was found to be significantly different between the population with locomotive dysfunction and the population without locomotive dysfunction ($p < 0.01$). Conversely, there were no significant differences between the population with locomotive dysfunction and the population without locomotive dysfunction with regard to gender and BMI.

The %YAM) of the SOS was significantly lower among the individuals diagnosed with locomotive dysfunction according to the GLFS-25 (a score of 16 or greater) than in the individuals regarded as having a healthy locomotive function (score of 15 or less) ($p < 0.001$). Moreover, significant associations of low back pain ($p < 0.01$), shoulder pain ($p < 0.05$) and knee pain ($p < 0.001$) with locomotive dysfunction were observed in their cohort, whereas no significant associations were noted for neck pain, back pain, elbow or wrist pain or hip pain and locomotive dysfunction.

Table 2 shows the associations between CMSP and locomotive dysfunction based on the GLFS-25 score after

Table 1 Association between locomotive dysfunction screened by the 25-question geriatric locomotive function scale and age, gender, body mass index, chronic musculoskeletal pain and bone status

	Locomotive dysfunction + (<i>n</i> = 43)	Locomotive dysfunction – (<i>n</i> = 244)	<i>p</i>
Age	70.1 ± 11.7	63.7 ± 10.8	0.002 ^a
Gender			
Female	32	155	
Male	11	89	0.167 ^b
BMI	23.5 ± 5.0	23.3 ± 2.9	0.762 ^a
Any pain (<i>n</i> = 150)	28	122	0.067 ^b
Neck pain (<i>n</i> = 42)	7	35	0.815 ^c
Back pain (<i>n</i> = 25)	5	20	0.555 ^c
Low back pain (<i>n</i> = 75)	19	56	0.003 ^b
Shoulder pain (<i>n</i> = 55)	13	42	0.045 ^b
Elbow or wrist pain (<i>n</i> = 39)	9	30	0.147 ^c
Hip pain (<i>n</i> = 14)	3	11	0.448 ^c
Knee pain (<i>n</i> = 54)	17	37	<0.001 ^b
%YAM of the SOS	68.2 ± 12.8	78.0 ± 13.5	<0.001 ^a

BMI body mass index, YAM young adult mean, SOS speed of sound of the calcaneus

^a Welch's test

^b Chi square test

^c Fisher's exact probability test

Table 2 The age-, gender- and body mass index-adjusted analysis for locomotive dysfunction screened by the 25-question geriatric locomotive function scale using logistic regression models

	Adjusted OR	95 % CI	<i>p</i>
Any pain	1.971	0.973–3.993	0.06
Neck pain	1.422	0.561–3.604	0.459
Back pain	1.499	0.506–4.446	0.465
Low back pain	2.608	1.296–5.247	0.007
Shoulder pain	2.164	1.004–4.665	0.049
Elbow or wrist pain	2.015	0.842–4.821	0.116
Hip pain	1.967	0.472–8.195	0.353
Knee pain	2.978	1.412–6.280	0.004
%YAM of the SOS	0.951	0.919–0.984	0.004

OR odds ratio, CI confidence interval, YAM young adult mean, SOS speed of sound of the calcaneus

adjusting for age, gender and BMI, while Table 2 also shows the associations between the bone status and locomotive dysfunction based on the GLFS-25 score after adjusting for age, gender and BMI.

In the logistic regression models, the %YAM of the SOS (OR 0.95, 95 % CI 0.91–0.98), low back pain (OR 2.60, 95 % CI 1.29–5.24), shoulder pain (OR 2.16, 95 % CI 1.00–4.66) and knee pain (OR 2.97, 95 % CI 1.41–6.28) were found to be factors significantly affecting the presence of locomotive dysfunction as identified based on the GLFS-25 scores.

In a single correlation analysis using Spearman's correlation coefficient to assess the presence of associations between the measured variables and the GLFS-25 scores, age ($r = 0.398$, $p < 0.001$) was identified to be positively correlated with the GLFS-25 score and gender ($r = -0.229$, $p < 0.001$). In addition, the %YAM of the SOS ($r = -0.317$, $p < 0.001$) negatively correlated with the GLFS-25 score, whereas BMI did not significantly correlate with this parameter. Furthermore, a multiple regression model adjusted for age, gender and BMI showed a significant correlation between the %YAM of the SOS and the GLFS-25 score ($\beta = -0.212$, $p = 0.001$).

Discussion

OP has been reported to not only be a risk factor for fragility fractures [31], but also a major condition that leads to a decrease in the activities of daily living [18, 32]. Therefore, subjects with OP alone must also be considered to have "locomotive syndrome" based on the concept of "locomotive syndrome" proposed by the JOA [1–3].

In the present study, we demonstrated that a decreased %YAM of the SOS was associated with locomotive dysfunction as evaluated by the use of GLFS-25 scores, and the %YAM of the SOS correlated with the GLFS-25 score. Muramoto et al. showed that the %YAM of bone mineral density correlated with the GLFS-25 score, similar to the findings of the present study [33]. On the other hand,

Muramoto et al. also reported that locomotive dysfunction identified using a cutoff score of 16 on the GLFS-25 was not associated with any differences in the bone mineral density [34], unlike that observed in this study. Because the subjects in the present study did not have any specific characteristics, including BMI, smoking habit, or alcohol habit, that is, the average BMI was 23.4 % and the rates of smoking and alcohol habits were 13.2 and 28.2 %, respectively [35], we speculate that the data of this cohort by and large reflect the general Japanese population. The varied results found between the previous study and the present study may be explained by differences in the age range of the subjects.

To date, the association between CMSP and locomotive dysfunction screened using the GLFS-25 score has not been adequately investigated [4, 33, 34]. In the present study, we demonstrated that low back pain, shoulder pain and knee pain are associated with locomotive dysfunction as identified by the use of the GLFS-25 scores. Based on these results, we speculate that preventing knee, lumbar and shoulder pathology is important for decreasing the number of patients with locomotive dysfunction.

There are some limitations associated with this study. First, this study is a cross-sectional study. Longitudinal studies are necessary to fully elucidate the associations between OP or CMSP and locomotive dysfunction. Second, we assessed the bone status using QUS, although measuring the bone mineral density via dual-energy X-ray absorptiometry is the gold standard for assessing OP [36]. However, it has been reported that the QUS parameters correlate with the bone mineral density [37, 38] and can be used to predict hip, wrist and non-spine fractures [39].

Third, the cause of CMSP could not be confirmed, because a detailed examination for the population with CMSP was not conducted in this study. Moreover, it may be possible that the recognition of each type of pain differs depending on the subject, because the area of CMSP was not clearly defined in this study. However, we believe that this study is, nevertheless, an important one, because the association between CMSP and locomotive dysfunction has not yet been sufficiently investigated.

In conclusion, we herein demonstrated that a poor bone status and CMSP were associated with locomotive dysfunction in 43 individuals within our cohort of 287 subjects.

Among the various types of CMSP, knee pain, low back pain and shoulder pain were more strongly associated with locomotive dysfunction. These results indicate that chronic pain in the lumbar, shoulder and knee areas may be important contributing factors for the etiology of locomotive dysfunction.

Compliance with ethical standards

Conflict of interest All authors certify they have no commercial associations that might pose conflicts of interest in connection with this article.

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