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Original Article

The critical cutoff point of the Zurich Claudication Questionnaire and the Japanese Orthopaedic Association score indicating locomotive syndrome in patients with lumbar spinal canal stenosis

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ABSTRACT

Background: Locomotive syndrome (LS) is a condition of decreased mobility caused by disorders of the locomotive organs. Lumbar spinal stenosis (LSS) is a LS disorder. The Japanese Orthopaedic Association score (JOA score) and the Zurich Claudication Questionnaire (ZCQ) are international evaluation tools for LSS. However, the relationship between LS and JOA score or ZCQ is unknown. This study aimed to clarify the correlations between LS progression and the values/parameters of the JOA score or ZCQ and to determine the critical cutoff point of the JOA score or ZCQ that indicates LS progression.

Methods: We recruited preoperative LSS patients (n = 82). Patients' mean age was 73.4 years. The study participants were evaluated using the 25-question Geriatric Locomotive Function Scale (GLFS), JOA score, and ZCQ (which consists of symptom severity and physical function), and the patients' health-related quality of life was assessed using EuroQoL-5 dimension (EQ-5D) utility values and the EuroQoL-visual analog scale (EQ-VAS). We investigated the correlations between the 25-question GLFS and each clinical variable and evaluated the critical cutoff point of each international evaluation tool to detect LS.

Results: There was a statistically significant correlation between 25-question GLFS and each clinical evaluation tool. LSS patients with LS showed significantly worse scores in the evaluation tools than LSS patients without LS. Moreover, we found that critical cutoff points of 17.5 on JOA score, 3.1 on ZCQ-symptom, and 2.3 on ZCQ-function could detect LS.

Conclusions: A statistically significant correlation exists between the 25-question GLFS and the JOA score or ZCQ. It might be important to perform decompression surgery for LSS patients before they reach the cutoff values of the several clinical evaluation tools to avoid LS progression.

Study design: Clinical prospective case–control study.

1. Introduction

The locomotive syndrome (LS) was introduced by the Japanese Orthopaedic Association (JOA) in 2007 [1]. Although LS is not a disease, it refers to circumstances wherein elderly people require nursing care or are at a high risk of requiring nursing care in the near future. Elderly people should be treated before they develop LS progression.

LS is generally diagnosed using the stand-up test, the two-step test, and the 25-question Geriatric Locomotive Function Scale (25-question GLFS) [2]. The 25-question GLFS is a new questionnaire comprising 25 questions that can detect LS. It is a self-administered, relatively comprehensive measure that consists of 25 items, including four questions regarding pain during the last month, 16 questions regarding activities of daily living during the last month, three questions regarding social functions, and two questions regarding mental health status during the last month. These 25 items are graded with a 5-point scale from no impairment (0 points) to severe impairment (4 points), and then arithmetically added to produce a total score (minimum 0, maximum 100). Higher scores are associated with worse locomotive function. A cutoff

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point of 16 was determined to have the highest sensitivity and specificity for identifying individuals with LS [2].

Basically, LS has three important causes that include degeneration of bones, muscles, and joints. There are many disorders within the LS spectrum, including osteoarthritis of the knee or hip, osteoporosis, sarcopenia, and lumbar spinal stenosis (LSS).

LSS is known to commonly affect elderly people. The chief symptoms involve the lower limbs and include leg pain and/or back pain with sensory and motor deficits in the lower legs that worsen after long distance walking. Failure of conservative treatment is an indication for surgery. Although we understand that the concept of LS is important for reducing nursing care, it is not commonly known worldwide, which might be attributable to a lack of understanding of the concept. To date, there are many international clinical evaluation tools for LSS, such as the Japanese Orthopaedic Association (JOA) score and the Zurich Claudication Questionnaire (ZCQ) [3]. We believe that, to understand LS, the relationship between the JOA score or ZCQ and the 25-question GLFS should be evaluated. Furthermore, we considered that if the JOA score or ZCQ could be used to detect LS using a cut-off value, it may be meaningful in clinical practice.

Therefore, the purpose of this study was to investigate the distribution of the 25-question GLFS in LSS patients and to clarify its relationship with clinical variables. In addition, we evaluated the critical cutoff point of the JOA score or ZCQ that indicates LS progression.

2. Materials and methods

This study was approved by a local institutional review board. We recruited consecutive LSS patients who underwent decompression surgery in our institution from 2017 April to 2019 October. Of these, we excluded patients on dialysis and those who refused to undergo clinical evaluations. We collected all data prospectively. We assessed 82 patients (male:female = 47:35, mean age: 73.4 years).

We preoperatively performed clinical evaluations using the 25-question GLFS, JOA score, and ZCQ. Moreover, we evaluated the health-related quality of life (HRQoL) using the European Quality of Life (EuroQoL)-5 dimension (EQ-5D) [4,5]. Although the ZCQ consists of three measurements, which evaluate symptom severity, physical function, and surgery satisfaction in LSS, we only used two components, symptom severity (ZCQ-symptom) and physical function (ZCQ-function), in this study. Regarding EQ-5D, all patients were assessed for HRQoL using EQ-5D utility values and the EQ-VAS (visual analog scale), which are standard instruments for measuring health outcomes.

Based on a previous report, we considered that a 25-question GLFS score of >16 points indicates the presence of LS [2]. We categorized all patients into two groups according to this cutoff point: non-LS group and LS group. Subsequently, we compared each clinical variable between the two groups.

2.1. Statistical analysis

First, correlations between the GLFS-25 score and clinical variables were assessed with Pearson's product–moment correlation coefficient. Second, regarding the comparison between the non-LS and LS groups, all variables were tested for distribution normality using the Shapiro–Wilks normality test. We used Student's t-test to assess the normality of the data, Mann Whitney U-test for the non-normality of the data, and Chi-squared test for sex comparison. Values of $p < 0.05$ were considered statistically significant.

To determine whether our grouping cut-off of LS was appropriate or not, the receiver operating characteristic (ROC) of the curve analysis was used to assess the optimal cut-off value of the clinical evaluation scores (JOA score, ZCQ-symptom, and ZCQ-function) that would indicate LS. The area under the curve (AUC) was analyzed, and the best sensitivity and specificity results were selected to represent the cut-off value. The ideal sensitivity and specificity of the cut-off values were determined by the corresponding reference line point that closely corresponded to the AUC value of 1.

All statistical analyses were performed using IBM SPSS Statistics 17 software (IBM Japan, Tokyo, Japan).

3. Results

3.1. Demographic data

The demographic and clinical characteristics of the participants are shown in Table 1. Among the patients, the 25-question GLFS score was 34.8 ± 19.1 (mean ± standard deviation) points (range: 4–86 points); the JOA score was 16.6 ± 4.8 points (range: 4–26 points); the ZCQ-symptom severity score was 3.2 ± 0.8 (range: 0.0–4.6); the ZCQ-function score was 2.5 ± 0.6 (range: 1.2–4.0); the EQ-5D utility value was 0.48 ± 0.30 (range: −0.215–1.0); and the EQ-VAS score was 58.0 ± 19.6 (range: 0–95).

3.2. Correlation between the 25-question GLFS and each clinical variable

Among all patients, a statistically significant correlation was found between the 25-question GLFS and JOA score ($r = -0.50$, $p < 0.01$) (Fig. 1), between the 25-question GLFS and the ZCQ-symptom score ($r = 0.47$, $p < 0.01$) (Fig. 2), between the 25-question GLFS and the ZCQ-function score ($r = 0.62$, $p < 0.01$) (Fig. 3), between the 25-question GLFS and EQ-5D utility values ($r = -0.48$, $p < 0.01$) (Fig. 4), and between the 25-question GLFS and the EQ-VAS score ($r = -0.41$, $p < 0.01$) (Fig. 5).

3.3. Comparison between the non-LS and LS groups according to 25-question GLFS cutoff score (>16 points)

Among the 82 LSS patients, 66 and 16 patients were categorized in the LS and non-LS groups, respectively. There was no statistically significant differences between the two groups in age ($p = 0.15$), sex ($p = 0.14$), and preoperative JOA score ($p = 0.08$) (Tables 2–4). There were statistically significant differences in ZCQ-symptom scores, ZCQ-function scores, EQ-5D utility values, and EQ-VAS scores between the two groups (Tables 2 and 3).

Table 1
Demographic data (n = 82).

	Mean ± SD	Median	25%–75%
Age	73.4 ± 8.4	75.0	69–79.3
Male, %	57%		
JOA score	16.6 ± 4.8	17.0	14–20.3
ZCQ symptom severity	3.2 ± 0.8	3.3	2.7–3.7
ZCQ physical function	2.5 ± 0.6	2.6	2.2–3.0
EQ-5D utility values	0.48 ± 0.30	0.6	0.16–0.69
EQ-5D-VAS	58.0 ± 19.6	60.0	49.5–70
25-Question GLFS	34.8 ± 19.1	30.5	20–49.3

JOA, Japanese Orthopaedic Association; ZCQ, Zurich Claudication Questionnaire; GLFS, Geriatric Locomotive Function Scale; EQ-5D, EuroQoL-5 dimension; EQ-VAS, EuroQoL-visual analog scale.

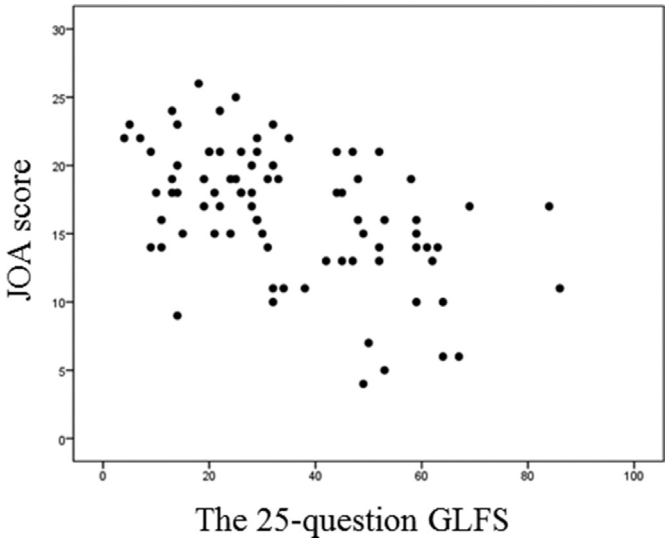

Fig. 1. Correlation between the 25-question GLFS and JOA score. JOA, Japanese Orthopaedic Association; GLFS, Geriatric Locomotive Function Scale.

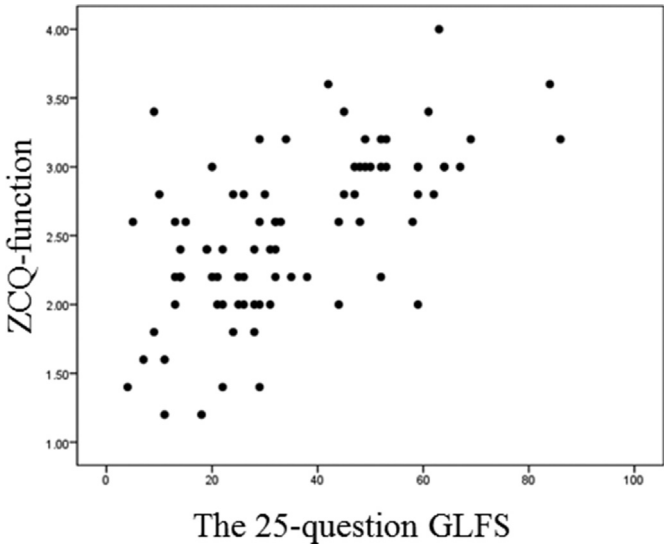

Fig. 3. Correlation between the 25-question GLFS and ZCQ physical function. ZCQ, Zurich Claudication Questionnaire; GLFS, Geriatric Locomotive Function Scale.

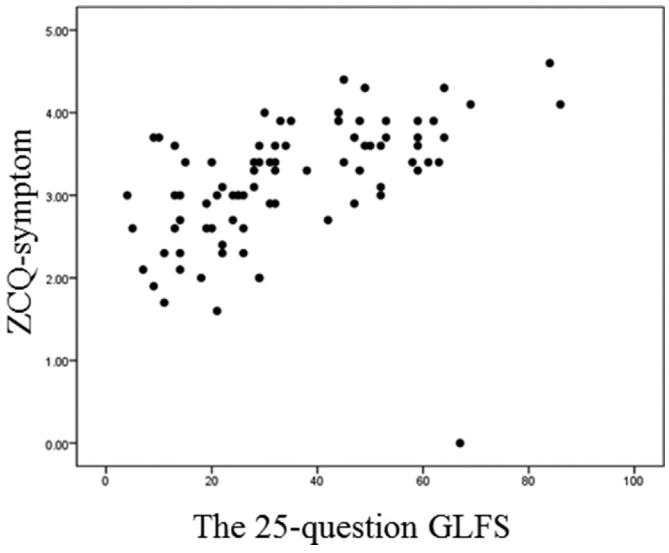

Fig. 2. Correlation between the 25-question GLFS and ZCQ symptom severity. ZCQ, Zurich Claudication Questionnaire; GLFS, Geriatric Locomotive Function Scale.

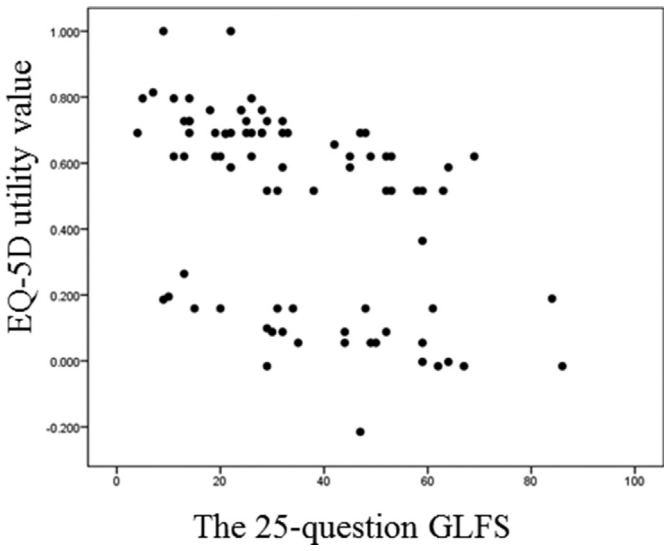

Fig. 4. Correlation between the 25-question GLFS and EQ-5D utility values. GLFS, Geriatric Locomotive Function Scale; EQ-5D, EuroQoL-5 dimension.

3.4. ROC curve analysis to determine the cut-off value for detecting LS (25-question GLFS > 16 points)

A JOA score of <17.5 points was the cut-off point for LS (AUC: 0.65; 95% CI: 0.50–0.80; sensitivity: 0.56, specificity: 0.69; $p = 0.07$). A ZCQ-symptom score of >3.1 points was the cut-off point for LS (AUC: 0.72; 95% CI: 0.58–0.86; sensitivity: 0.65, specificity: 0.75; $p < 0.01$). A ZCQ-function score of >2.3 points was observed as the cut-off point for LS (AUC: 0.70; 95% CI: 0.56–0.84; sensitivity: 0.67, specificity: 0.63; $p = 0.01$).

4. Discussion

In this study, our results showed that there were statistically significant positive or negative correlations between the 25-question GLFS and all clinical evaluation tools, including HRQoL. Furthermore, the LS group showed worse scores on all clinical evaluation tools, except for the JOA score, and lower HRQoL than the non-LS group. Based on the ROC curve analysis, we determined the cut-off points of the JOA score or ZCQ for detecting LS, which are as follows: 17.5 for JOA score, 3.1 for ZCQ-symptom, and 2.3 for ZCQ-function.

As we previously mentioned, LS is partly due to diseases of the locomotive organs, such as osteoarthritis, lumbar spinal canal stenosis, osteoporosis, and rheumatoid arthritis [1]. LS is associated with symptoms such as pain, limited joint range of motion, reduced balancing ability, slow walking speed, and frequent falls [6]. LS is divided into the following two stages: stage 1 indicates the beginning of mobility function decline and stage 2 indicates further progression in mobility function decline. Seichi et al. proposed the use of >16 points on the 25-question GLFS to determine stage 2 of the disease [2]. Given that we aimed to treat the locomotive organs, such as LSS, before LS stage 2 occurs, to prevent the need of nursing care or reduce the risk of nursing

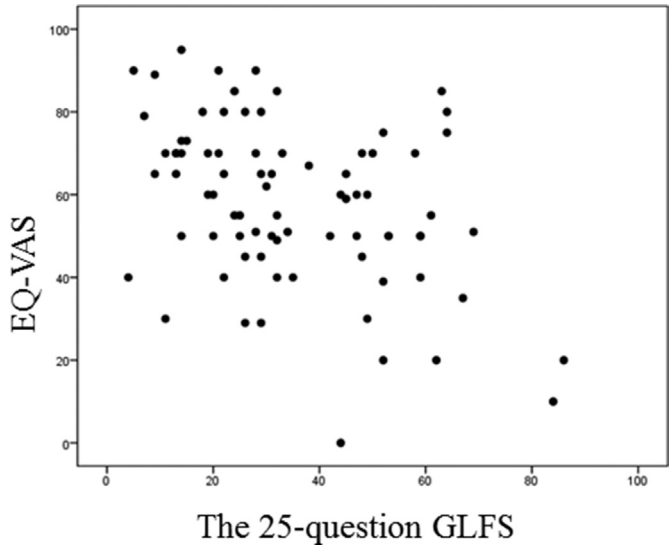

Fig. 5. Correlation between the 25-question GLFS and the EQ-VAS. GLFS, Geriatric Locomotive Function Scale; EQ-VAS, EuroQoL-visual analog scale.

Table 2
Comparison of the data between LSS patients with LS and those without LS.

	LSS patients without LS (n = 16)		LSS patients with LS (n = 66)		p value
	Median	25–75%	Median	25–75%	
Age	72	64.3–77.8	75	69.0–80.1	0.15
EQ-5D utility values	0.71	0.35–0.80	0.59	0.10–0.69	<0.01
25-Question GLFS	12	9.0–14.0	34.5	26.0–52.3	<0.01

Mann Whitney U-test.
LS, locomotive syndrome; LSS, lumbar spinal stenosis; GLFS, Geriatric Locomotive Function Scale; EQ-5D EuroQoL-5 dimension.

care requirement in the near future in elderly individuals, we used the 25-question GLFS score of >16 points as the cutoff point to detect LS.

In our study, we found that all clinical variables in LSS patients with LS were worse than those of LSS patients without LS. LS clearly affected LSS severity. Currently, Fujita et al. [7] reported that lumbar spinal surgery for LSS improved the stage of locomotive syndrome among elderly patients with LSS at a rate of 23%. Meanwhile, their data showed that 77% of patients with LSS did not experience LS improvement even after surgery. Based on their study findings, we consider that it might be better to perform surgery for patients with LSS before LS progression develops. However, we are yet to establish the critical timing of surgery for patients with LSS. Therefore, in clinical practice, it might be important to determine the critical timing of surgery before LS progression.

Our study showed the cut-off value indicating LS progression on several clinical evaluation tools for LSS. We believe that these cut-off values might be meaningful to determine the timing of surgery. As mentioned previously, the 25-question GLFS is basically an evaluation tool for LS [2,8,9], although currently, several authors have reported that it can be used for osteoarthritis of the hip joint [10] and rheumatoid arthritis [11,12]. To the best of our knowledge, this is the first report that has clarified the relationship between the 25-question GLFS and clinical evaluation tools regarding LSS. Furthermore, the 25-question GLFS not only showed the degree of LS, but also the degree of severity for LSS.

Table 3
Comparison of data between the LSS patients with LS and those without LS.

	LSS patients without LS (n = 16)		LSS patients with LS (n = 66)		p value
	Mean	±SD	Mean	±SD	
JOA score	18.5	4.1	16.2	4.8	0.08
ZCQ symptom severity	2.7	0.7	3.3	0.7	0.01
ZCQ physical function	2.2	0.6	2.6	0.6	0.01
EQ-5D-VAS	68.6	17.7	55.6	19.3	0.02

Student t-test.
LS, locomotive syndrome; LSS, lumbar spinal stenosis; JOA, Japanese Orthopaedic Association, ZCQ, Zurich Claudication Questionnaire; GLFS, Geriatric Locomotive Function Scale; EQ-5D EuroQoL-5 dimension.

Table 4
Comparison of the data between the LSS patients with LS and those without LS.

	LSS patients without LS (n = 16)	LSS patients with LS (n = 66)	p value
Male	8	39	0.14
Female	8	27	

Chi square test.

Our study had some limitations. First, the number of the subjects was small, and the subjects were chosen from the LSS population who underwent surgical treatment; thus, a selection bias may have been introduced, and our results may not be generalizable. Second, this study focused on the correlation between the 25-question GLFS and preoperative clinical variables. Moreover, it is unclear whether surgical intervention improved these clinical variables or not. This will require further study in the future. Third, this study focused on the relationships among the preoperative clinical variables; thus, it remains unclear whether the 25-question GLFS improved postoperatively or not. Further studies are needed to investigate this. Fourth, the degree of LS normally should be evaluated by a combination of the two-step test, stand-up test, and the 25-question GLFS. Therefore, our study involved a limited analysis because we only used the 25-question GLFS to evaluate the degree of LS. Fifth, our study only collected preoperative data and had a cross-sectional analytical design. We may need to perform a longitudinal study to clarify whether a causal relationship exists between LSS and LS. Sixth, LSS was diagnosed in our subjects based on physical examination and MRI. However, the patients may have also had other musculoskeletal disorders such as knee osteoarthritis or hip osteoarthritis at that time. We could not exclude the effect of other musculoskeletal disorders on the degree of LS in this study.

5. Conclusion

The 25-question GLFS was significantly related to the JOA score and ZCQ. Among LSS patients, the 25-question GLFS could show the degree of severity of symptoms.

LSS patients with LS showed statistically significant worse ZCQ-symptom and ZCQ-function scores, as well as HRQoL, than LSS patients without LS. It may be important to perform surgery in LSS patients before they obtain the cutoff value of these clinical evaluation tools.

Sources of Funding

None declared.

Declaration of Competing Interest

None declared.

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