Surgery Can Improve Locomotive Syndrome Due to Lumbar Spinal Canal Stenosis and Loco-Check Can Predict Best Timing of Surgery to Avoid Progress of Locomotive Syndrome

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Abstract:

Introduction: The loco-check is a simple tool for evaluating locomotive syndrome (LS), and a previous report suggested that it can be used to identify patients with stage 2 LS. The purpose of this study was to investigate the improvement in LS stage after surgery based on the loco-check in elderly patients with lumbar spinal stenosis (LSS) and to clarify the characteristics associated with improvement to non-stage 2 LS.

Methods: We reviewed 40 elderly patients with LSS who underwent surgery at our institution. We compared the pre- and postoperative Japanese Orthopaedic Association score, loco-check, Oswestry Disability Index, EuroQoL-5 dimension utility values, and the EuroQoL-visual analog scale. We divided patients according to the presence or absence of stage 2 LS after surgery and compared their preoperative clinical findings and assessment measures.

Results: Ninety percent of all patients had been preoperatively diagnosed with stage 2 LS according to the loco-check. After surgery, patients showed a decreased number of affirmative answers on the loco-check, according to which only 65% were postoperatively diagnosed with stage 2 LS. The receiver operating characteristic curve analysis identified less than four affirmative answers on the loco-check before LSS as predictive of improvement to non-stage 2 LS.

Conclusions: Surgical treatment for elderly patients with LSS could improve LS. In patients with less than four affirmative answers on the loco-check preoperatively, improvement to non-stage 2 LS status may be possible.

Keywords:

elderly, Japanese Orthopaedic Association score, loco-check, locomotive syndrome, lumbar spinal canal stenosis, surgery

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Introduction

The Japanese Orthopaedic Association (JOA) suggested the concept of locomotive syndrome (LS) to refer to a medical condition in which an elderly person may require nursing services as a result of weakness of the locomotive organs, such as the muscles, bones, and joints[1]. Stage 1 LS is defined as mobility function starting to decrease, while stage 2 indicates further progression of mobility function. LS can be objectively diagnosed using three evaluation tools: (1) the stand-up test, (2) the two-step test, and (3) the 25-question geriatric locomotive function scale (25-question GLFS)[2]. Furthermore, a self-check tool, termed the loco-check, can easily evaluate whether or not a person has a risk for LS.

The loco-check is a simple, seven-point questionnaire that evaluates daily activities and is an acceptable tool for detecting LS in the early stages. The loco-check has been introduced as an initial self-check tool, where more than one affirmative answer suggests the presence of LS. Furthermore, there have been several reports of other useful clinical applications. Shigematsu et al.[3] reported that two affirmative answers on the loco-check are the cutoff for detecting stage 2 LS. Noge et al.[4] clarified that the number of affirmative answers on the loco-check was significantly related to physical activity and the physical health section of the Medical Outcomes Study 36-item short form. Furthermore, Iizuka et al.[5] reported that the number of affirmative answers on the loco-check was negatively related to health-related quality of life (HRQoL) measures, such as the European Quality of Life-5 dimension (EQ-5D) and EQ-visual analog scale (EQ-VAS).

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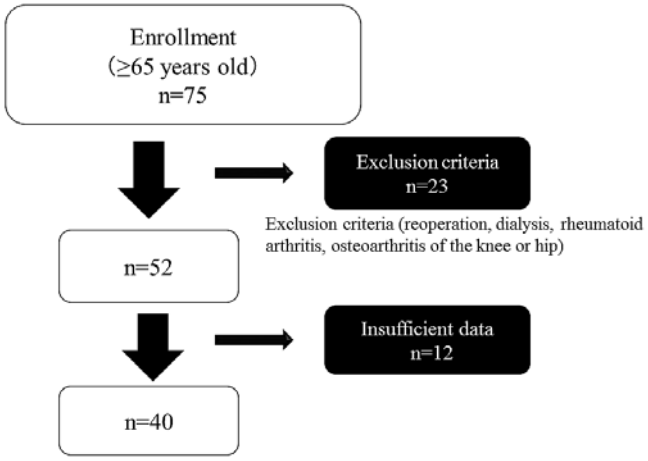

Figure 1. Flowchart showing patient selection.

Lumbar spinal canal stenosis (LSS) is considered a risk factor for LS[2], and its severity may be associated with LS progression[6,7]. Fujita et al.[7] showed that aggressive surgical treatment for LSS improved stage 2 LS in elderly patients. In their study, they used three evaluation tools, the stand-up test, the two-step test, and the 25-question GLFS, for the diagnosis of LS stage. However, we consider that these three tests need space and time for completion. In addition, these tests can be associated with complications such as falling. Moreover, it may be difficult to introduce such tests in a clinical setting. Due to the simplicity of the loco-check, it has the potential to evaluate stage 2 LS and HRQoL. To the best of our knowledge, few studies have focused on the change in loco-check results from pre- to post-decompression surgery in patients with LSS.

Therefore, this study aims 1) to determine improvement on the loco-check after surgery for elderly patients with LSS and 2) to clarify the preoperative characteristics of patients who can improve to a condition less severe than stage 2 LS.

Materials and Methods

This research has been approved by the IRB of the authors' affiliated institution. Participants were briefed of their choice to opt out of the study. We retrospectively reviewed 75 patients who were 65 years of age or older and had undergone spinal surgery for LSS at our institution between June 2016 and March 2018. Surgery was indicated for patients who exhibited buttock pain, leg pain, intermittent claudication, and cauda equina disorder due to LSS that was resistant to conservative therapy. We excluded patients undergoing reoperation, those on dialysis, and those with rheumatoid arthritis. We also excluded patients with osteoarthritis of the knee and hip (greater than grade 2 according to the Kellgren and Lawrence classification), because osteoarthritis might affect condition of LS stages. A total of 40 patients were included in this study (Fig. 1).

Clinical outcomes

We evaluated the (1) loco-check, (2) Oswestry Disability Index (ODI), (3) JOA score, and (4) HRQoL (EQ-5D utility values and EQ-5D VAS) scores preoperatively and at least 1 year after surgery.

Participants answered the loco-check questions with either a "yes" or a "no," and the number of affirmative answers was recorded. The specific items on the loco-check are as follows:

#1. You cannot put your sock on while standing on one leg.
#2. You often trip or slip around the house.
#3. You need to hold on to the handrail when climbing the stairs.
#4. You have difficulty doing moderately heavy housework.
#5. You have difficulty carrying home 2 kg of shopping (i.e., equivalent to two 1-L cartons of milk).
#6. You cannot walk for a quarter of an hour without stopping.
#7. You cannot finish crossing the road before the light turns red.

Evaluation of stage 2 LS

Based on a previous report[3], we defined patients who had more than two affirmative answers on the loco-check as having stage 2 LS. In addition, we considered patients with no or one affirmative answer on the loco-check as patients without stage 2 LS. We compared the characteristics of patients with or without stage 2 LS after surgery.

Statistical analyses were conducted using the paired *t*-test, Mann-Whitney *U* test, and chi-square test. In particular, a comparison between preoperative and postoperative clinical outcomes was performed using the paired *t*-test. The chi-square test was used to examine the change in the number of affirmative answers to each question in the loco-check from before surgery to after surgery, whereas the Mann-Whitney *U* test was employed to compare patients with and without stage 2 LS postoperatively.

Receiver operating characteristic (ROC) of the curve analysis was used to evaluate the optimal cutoff value regarding prediction of the absence of stage 2 LS after surgery. Area under the curve (AUC) analysis was performed, and the best sensitivity and specificity results were selected to represent the cutoff value. The ideal sensitivity and specificity cutoff values were determined by the corresponding reference line point that closely corresponded to an AUC value of 1. Values of $p<0.05$ were considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics 17 software (IBM Japan, Tokyo, Japan).

Results

Demographic data

The patients' median age was 75.4 years (male/female= 23:17). The median number of intervertebral levels decom-

pressed was 2, and instrumented fusion was performed in nine patients (Table 1). The mean follow-up period was 1.4± 0.5 years after surgery.

Clinical outcomes

In this study, a statistically significant improvement in all clinical outcome measures was observed from pre- to post-operation (Table 2). Although all patients with LSS had at least one affirmative answer on the preoperative loco-check, the number of affirmative answer significantly decreased postoperatively (Fig. 2). Specifically, we found that the number of affirmative answers to each question significantly decreased postoperatively, with the exception of questions # 2 and #7 (Table 3).

Characteristics of patients with or without stage 2 LS postoperatively

Based on the number of affirmative answers on the loco-check, we diagnosed stage 2 LS in 36 patients (90%) preoperatively and in 26 patients (65%) postoperatively. We subsequently compared patients with and without stage 2 LS postoperatively. There were statistically significant differences in the number of affirmative answers on the loco-check, ODI, and EQ-5D utility values preoperatively (Table 4). Furthermore, there were statistically significant differences in the number of affirmative answers on the loco-check, JOA score, ODI, and EQ-5D utility values postoperatively (Table 4). ROC curve analysis was performed to assess the cutoff value of the number of affirmative answers on the loco-check that would predict maintenance or improvement of LS to less than stage 2 after surgery. Four affirmative answers were determined to be the cutoff value (AUC, 0.82; 95% confidence interval (CI), 0.69-0.96; sensitivity, 0.81; specificity, 0.71; $p<.01$) (Fig. 3).

Table 1. Patients' Demographic Data (n=40).

	Median	25%–75%
Age (years)	75.4	72–78.8
Sex (male, %)	57.5	
Number of decompressions	2	1–3
Surgery involving instrumentation %	22.5	

Discussion

In this study, we focused on the relationship between the clinical outcomes of LSS surgery and LS. Orthopedic surgeons should attempt to specifically prevent stage 2 LS in elderly patients as it indicates a further decline in mobility function and a requirement of nursing services.

All patients undergoing surgery for LSS in this study had at least one affirmative answer on the preoperative loco-check, and 90% (36/40 patients) had more than two affirmative answers. Therefore, most patients had stage 2 LS due to LSS before surgery. We showed that the number of affirmative answers on the loco-check significantly decreased after surgery, with 14 patients (35%) being classified as non-stage 2 LS. These results are consistent with those in previous reports[7]. Furthermore, the results of clinical measures, such as the JOA score, ODI, and HRQoL, also improved postoperatively. In terms of specific items on the loco-check, two items (#2 and #7) did not significantly improve (Table 3). However, we do not have sufficient data to explain why these items did not improve. Further studies are needed to clarify this issue.

Significance of the number of affirmative answers on the loco-check

In this study, we used the loco-check to assess clinical outcomes due to its simplicity and usefulness. In fact, an increased number of affirmative answers on the loco-check had been associated with several issues such as decreased physical activity and physical health section scores on the Medical Outcomes Study 36-item short form[4], decreased HRQoL[5], and decreased JOA scores[6]. Furthermore, it is an indicator of decreased locomotive function[3] and of the risk of falls within 1 year[8]. With regard to locomotive function,

Table 2. Clinical Outcome Measures Pre- and Post-operation.

	Pre-operation		Post-operation		*p*-value
	Mean	SD	Mean	SD	
Follow-up periods			1.4	0.5	N/A
Number of affirmative answers on the loco-check	4.3	1.8	2.4	1.8	<0.01
JOA score	14.2	4.2	22.2	4.3	<0.01
ODI (%)	45.2	17.3	29.4	18.5	<0.01
EQ-5D utility score	0.47	0.30	0.68	0.23	<0.01
EQ-5D VAS score	57.2	19.0	67.3	19.7	0.03

SD: standard deviation
N/A: not available
JOA: Japanese Orthopaedic Association
ODI: Oswestry Disability Index
EQ-5D: European quality of life-5 dimensions
EQ-5D VAS: European quality of life-visual analog scale

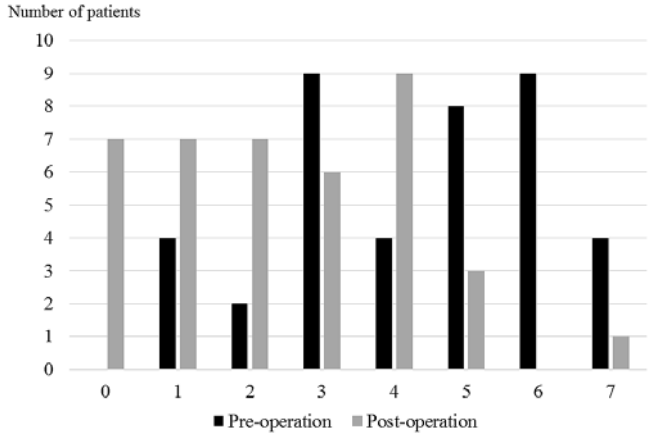

Figure 2. Change in the number of affirmative answers on the loco-check from pre- to post-operation.

two affirmative answers on the loco-check are the threshold for identifying stage 2 LS[3], as mentioned above.

Which patients could become non-stage 2 LS after surgery?

We believe that it is important to preoperatively determine which patients could improve to non-stage 2 LS after surgery to prevent progression of the disease. In this study, patients with fewer affirmative answers on the loco-check and lower ODI scores preoperatively were able to maintain or improve their LS stage after surgery (Table 4). According to the ROC curve analysis, four affirmative answers were determined to be the cutoff value (AUC, 0.82; 95% CI, 0.69-0.96; sensitivity, 0.81, specificity, 0.71; $p<.01$). That is, surgery was helpful in maintaining or improving the LS stage, and early surgical intervention in patients with less than four affirmative answers on the loco-check might be recommended.

To date, few studies have clarified whether surgical treat-

Table 3. Affirmative Answers on the Loco-check Pre- and Post-operation.

Statements on the loco-check	Pre-operation	Post-operation	*p*-value
	Number of affirmative answers (%)		
You cannot put your sock on while standing on one leg	35 (87.5)	26 (65.0)	0.02*
You often trip or slip around the house	14 (35.0)	8 (20.0)	0.13
You need to hold on to the handrail when climbing the stairs	34 (85.0)	25 (62.5)	0.02*
You have difficulty doing moderately heavy housework	30 (75.0)	17 (42.5)	<0.01*
You have difficulty carrying home 2 kg of shopping	22 (55.0)	13 (32.5)	0.04*
You cannot walk for a quarter of an hour without stopping	31 (77.5)	6 (15.0)	<0.01*
You cannot finish crossing the road before the light turns red	7 (17.5)	3 (7.5)	0.18

Table 4. Comparison Regarding Preoperative and Postoperative Factors between the Patients with Stage 2 LS and with Non-stage 2 LS after Surgery.

		Postoperative LS stage				*p*-value
		Non-stage 2 LS (n=14)		Stage 2 LS (n=26)		
		Median	25%–75%	Median	25%–75%	
Preoperative factors	Age (year)	74	70.0–78.0	76	72.0–80.0	0.27
	Number of affirmative answers on the loco-check	3	1.8–4.3	5	4–6	<0.01*
	JOA score	14.5	12.8–19.3	13.5	10.0–16.3	0.26
	ODI (%)	34.3	22.6–38.9	53.3	43.4–58.9	<0.01*
	EQ-5D utility score	0.69	0.62–0.72	0.52	0.11–0.62	0.02*
	EQ-5D VAS score	62.5	45.0–73.8	56	37.5–71.0	0.38
Postoperative factors	Number of affirmative answers on the loco-check	0.5	0–1	3.5	2–4	<0.01*
	JOA score	26	22.5–28.0	20.5	17.8–24.0	<0.01*
	ODI (%)	15.6	5.3–20.0	36.7	22.6–50.0	<0.01*
	EQ-5D utility score	0.8	0.69–0.94	0.66	0.52–0.80	0.02*
	EQ-5D VAS score	80	550–87.5	67.5	50–76.3	0.28

JOA: Japanese Orthopaedic Association
ODI: Oswestry Disability Index
EQ-5D: European quality of life-5 dimensions
EQ-5D VAS: European quality of life-visual analog scale
LS: locomotive syndrome

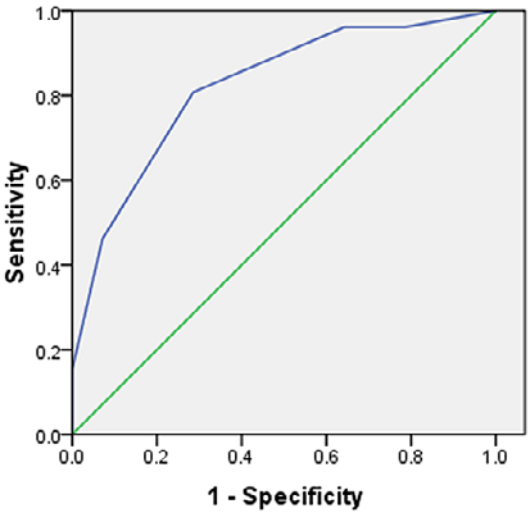

Figure 3. Receiver operating characteristic curve for the loco-check cutoff that can predict non-stage 2 locomotive syndrome after lumbar spinal stenosis surgery.

ment for patients with LSS can improve LS[7,9]. We believe that our results will help spine surgeons better educate patients with LSS on how to avoid progression of LS and when surgery would be recommended.

This study has several limitations. Firstly, the number of patients was relatively small and might not be sufficient to draw proper conclusions. Secondly, the patients did not have only LSS but also osteoporosis, advanced age, and osteoarthritis, which are related to LS. Although we excluded patients with LSS and osteoarthritis of the knee and hip from this study, it was difficult to exclude all other diseases related to LS completely. Thirdly, the loco-check is not a standard tool for determining LS stage. Strictly speaking, our loco-check evaluation may have been incapable of evaluating the improvement in LS. However, the major finding in this study was the demonstration of the loco-check cutoff point, knowledge of which may help to prevent the progression of LS. We believed that it would be difficult to determine the critical threshold associated with progression of LS using the three tools of the stand-up test, the two-step test, and the 25-question GLFS.

Conclusions

Our results showed that the number of affirmative answers on the loco-check decreased significantly after surgical treatment in elderly patients with LSS. Fourteen patients (35%) no longer had LS after surgery. Surgical treatment is beneficial for improving LS among patients with LSS, especially in patients with less than four affirmative answers on the loco-check.

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Author Contributions: Hideki Shigematsu: the conception of the work
Masato Tanaka: drafting the work
Keisuke Masuda: the design of the work
Sachiko Kawasaki: the acquisition of data
Yuma Suga: the acquisition of data
Yusuke Yamamoto: the analysis of data
Yasuhito Tanaka: the interpretation of the data

Ethical Approval: This study was approved by the Nara Medical University Institutional Ethics Committee (approval number 1976).

Informed Consent: Informed consent was obtained from the participants.

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