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Factors Associated with the Oswestry Disability Index Score One Month after Lumbar Discectomy

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Abstract. [Purpose] The objective of this study was to identify preoperative and early postoperative factors contributing to the Oswestry Disability Index (ODI) score one month after lumbar discectomy, to help with future physiotherapy. [Subjects] The 98 subjects included in our study were diagnosed lumbar disc herniation (LDH) and underwent initial discectomy at our hospital. [Methods] Factors investigated included sex, age, height, weight, hernia level, surgical procedure, smoking habit, profession, leg muscle strength, and degree of back pain, leg pain and numbness, ODI score, and ODI sub-scores. A stepwise multiple regression analysis was used for statistical analysis, with the dependent variable being the one month postoperative ODI score, and independent variables comprising the other factors monitored preoperatively listed above, on resumption of activity (5th postoperative day), and on discharge (9th postoperative day). [Results] Factors contributing to the ODI score one month after lumbar discectomy were profession (desk work), back pain before surgery, leg pain on resumption of activity, ODI score, ODI traveling sub-score, and leg pain on discharge. [Conclusion] Early postoperative physiotherapy should comprise ongoing physical therapy to alleviate residual symptoms, patient education focusing on sitting posture, and exercise therapy.
Key words: Lumbar Disc Herniation, Lumbar Discectomy, Oswestry Disability Index

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INTRODUCTION

Lumbar disc herniation (LDH) is one of the most common spinal disorders[1, 2]. LDH occurs in approximately 1% of the population in the United States, but its prevalence in Japan is unknown[1, 3]. A conservative approach is the first choice of treatment in the vast majority of cases, but surgical treatment is indicated in patients with cauda equina disorder or severe paralysis of the legs, or in patients who have undergone various types of conservative treatment without obvious improvement[1, 4]. Surgical treatment is performed with a yearly frequency of 46.3 individuals per 100,000 population[5] and postoperative outcomes are generally good[1, 6–8].

The Japan Orthopaedic Association (JOA) score, the most commonly used index of postoperative outcome in Japan, is based mainly on evaluation by doctors[1, 9]. In recent years, however, greater importance has come to be placed on patient-centered medicine, in particular, the perspective of evidence-based medicine. Patient-based evaluations focusing on quality of life (QOL) are now emphasized over evaluations by medical professionals[9]. Patient-based evaluation is also an indispensable index in physiotherapy for engaging in multifaceted interventions that address both individual living environments and psychological and social aspects.

The most commonly used patient-based evaluations following lumbar discectomy include the Oswestry Disability Index (ODI)[10], the Roland-Morris Disability Questionnaire (RMDQ)[11], the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ)[12], and the Short-Form 36 (SF-36)[13]. Of these, the ODI has been the most widely used globally for many years as it comprises few questions and is easy to interpret. The Japanese version of the ODI was published in 2003 by Fujiwara et al.[14], who stated that its internal consistency (Cronbach α) was 0.83 and its reproducibility had a correlation coefficient of $r = 0.93$. It has also been reported as having correlation coefficients of $r = 0.79$ with the RMDQ and $r = -0.52$ to -0.82 with the SF-36 subscale. The reliability and validity of the Japanese version of the ODI have thus been established[14, 15]. Therefore, the ODI score is regarded as a valuable tool for determining the effectiveness of physiotherapy as a patient-based evaluation of treatment outcome following lumbar discectomy.

According to Puolakka et al.[16], an ODI score of ≥20 two months after discectomy is a risk factor for increasing the number of sick-leave days 5 years postoperatively. Häkkinen et al.[17] also reported that the ODI score 6 weeks postoperatively is an influential factor predicting patients' conditions

1 year after surgery. These findings indicate that the early postoperative ODI score influences long-term prognosis.

The ODI score is calculated from the sub-scores of a total of 10 questions but few reports have focused on these sub-scores themselves. Häkkinen et al.[17] investigated differences in sub-scores of LDH patients by gender and found that women scored higher than men in terms of walking, sex life, social life, and traveling. In a previous study, we used sub-scores to investigate LDH patients with poor postoperative outcomes, and found that a significantly higher number of such patients complained of difficulty in sitting[18]. The contribution of culture, national characteristics, and socioeconomic issues cannot be ruled out in the analysis of sub-scores, and a specific Japanese evaluation is important. In Japan, however, the postoperative ODI score or ODI sub-scores are regarded as the main outcomes and no other reports have investigated these in detail.

Therefore, the objective of this study was to identify preoperative and early postoperative factors contributing to the ODI score one month after lumbar discectomy, to help with future physiotherapy.

SUBJECTS AND METHODS

There were 435 patients who were diagnosed with LDH and underwent initial discectomy at our hospital between July 1, 2007 and December 31, 2010. The following exclusion criteria were applied: (a) patients who underwent discectomy at multiple levels; (b) patients who underwent fusion; (c) patients who were evaluated by staff other than the authors; and (d) patients who did not fill in the questionnaire completely or for whom other information was omitted. After elimination by the exclusion criteria,98 subjects remained and were included in our study. Surgery was performed using either the modified Love procedure or micro-endoscopic discectomy (MED). Postoperative aftercare followed our hospital's clinical path and comprised preoperative evaluation on the day before surgery (before surgery), walking with a walking frame in the ward from the day after surgery, exercise therapy and practicing movements involved in activities of daily living (ADL) (resumption of activity) according to the condition of each patient from the 5th postoperative day, and discharge from hospital on the 9th postoperative day (on discharge). Patients were instructed to continue exercise therapy at home, and follow-up after discharge was performed around one month after surgery (on return visit).

The factors surveyed or measured for this study constituted information required for everyday clinical treatment, and did not comprise experimental interventions. Full care was taken, however, to comply with the Helsinki Declaration. Prior to obtaining their consent, subjects were adequately informed of the concept of the study, its objective and methods, that their participation was voluntary, that they were free to withdraw their consent, and that their privacy would be protected.

The factors investigated were all taken from the hospital database, patient records, and surgical records.

The ODI was self-administered using the Japanese version of the ODI ver.2.0[14]. Evaluations were carried out before surgery, on discharge, and on the return visit. The ODI is comprised of a total of 10 sections: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and traveling. The section on sex life tends to have a low response rate in Japan due to national characteristics and was omitted from this study following Fujiwara et al.[14], who stated that it should be excluded from the start. Each section consists of 6 graded responses, scored more highly with increasing severity (0–5 points). The ODI score was calculated as a percentage of the maximum number of points (45) for all nine categories. ODI sub-scores (points) for each section were also investigated.

The other factors evaluated were preoperative age, height, weight, disease duration, sex, affected side, herniated level, surgical procedure, smoking habit, profession, bladder function, leg muscle strength, and degree of back pain, leg pain, and leg numbness. The degree of back pain, leg pain, and leg numbness were also evaluated on resumption of activity and on discharge. Disease duration was counted as the number of days between the date of the most recent acute exacerbation and the date of hospital admission. For their profession, patients were asked to choose one of three options: desk work (mainly carried out while seated), heavy labor (physical labor mainly carried out while standing), or other (neither of these). Bladder function was taken from the sub-items of the JOA score[19]. Leg muscle strength was obtained using Daniels' manual muscle test[20] on each of the psoas major/iliacus, quadriceps femoris, anterior tibialis, extensor digitorum longus/extensor, digitorum brevis, extensor hallucis longus, flexor digitorum longus/flexor digitorum brevis/flexor hallucis longus, and soleus/gastrocnemius muscles. In this study, muscle strength was categorized into three grades; ≥4 (normal/mild decline), 3 (moderate decline), and ≤2 (severe decline), with the lowest value taken as representative leg muscle strength. A visual analogue scale (VAS)[21] was used to evaluate back pain, leg pain, and leg numbness.

For the statistical analysis, Friedman's rank sum test and Shaffer's multiple comparison procedure were used to investigate changes over time in back pain, leg pain, leg numbness, ODI sub-scores, and ODI score. Stepwise multiple regression analysis was used, with the dependent variable being the ODI score on the return visit, and the independent variables being the other factors, preoperatively, on resumption of activity (5th postoperative day), and on discharge (9th postoperative day) (Table 1). SPSS ver. 12.0 for Windows (SPSS Japan Inc.) was used for data collation and analysis.

RESULTS

Basic subject information is provided in Table 2, the various follow-up periods (resumption of activity, discharge, and return visit) in Table 3, and VAS scores for back pain, leg pain, and leg numbness, ODI score, and ODI sub-scores at each follow-up period are in Table 4.

Back pain, leg pain, and leg numbness improved significantly compared with preoperative scores at all three

Table 1. The dependent variable and independent variables for stepwise multiple regression analysis

dependent variable:	return visit (one month after surgery)	· ODI score
independent variables:	1) before surgery (the day before surgery)	· age · height · weight · disease duration · sex · affected side · herniated level · surgical procedure · smoking habit · profession · bladder function · leg muscle strength · degree of back pain · degree of leg pain · degree of leg numbness · ODI score · ODI sub-scores (9 sections)
	2) resumption of activity (the 5th postoperative day)	· degree of back pain · degree of leg pain · degree of leg numbness
	3) discharge (the 9th postoperative day)	· degree of back pain · degree of leg pain · degree of leg numbness · ODI score · ODI sub-scores (9 sections)

Table 2. Basic subject information

	mean	SD	median	quartile range
age (years)	37.9	12.2	36.0	17.0
height (cm)	165.5	9.3	164.5	14.4
weight (kg)	64.8	14.1	61.6	18.4
disease duration (day)	74.4	80.3	60.0	67.0

sex (n)	male:56 female:42
affected side (n)	right:40 left:53 bilateral:5
herniated level (n)	L3/4:4 L4/5:38 L5/S1:56
surgical procedure (n)	modified Love procedure:67 MED*:31
smoking habit (n)	yes:48 no:50
profession (n)	heavy labor:36 desk work:30 other :32
bladder function (n)	normal:80 mild dysfunction:18 severe dysfunction:0
leg muscle strength (n)	normal/mild decline:68 moderate decline:17 severe decline:13

SD: Standard Deviation, *MED:Micro Endoscopic Discectomy

Table 3. Follow-up periods (resumption of activity, discharge, and return visit)

	mean	SD	median	quartile range
resumption of activity (day)*	5.1	1.0	5.0	4.0
discharge* (day)	9.2	2.9	9.0	4.0
return visit* (day)	27.8	8.4	26.0	6.0

SD: Standard Deviation, *: the number of days from operation

follow-up periods ($p<0.05$). Significant improvements were also seen on resumption of activity compared with on discharge and on return visit ($p<0.05$), but no obvious change was evident between discharge and the return visit.

The ODI score and sub-scores all improved significantly on discharge and on return visit compared with preoperative scores ($p<0.05$), with the exception of the ODI lifting sub-score on discharge. A comparison of scores on discharge and on return visit showed marked improvements in all items ($p<0.05$) with the exception of the ODI score and pain sub-score.

Preoperative factors affecting the ODI score one month postoperatively were profession (desk work) and back pain; on resumption of activity was leg pain; and those on discharge were ODI score, ODI traveling sub-score, and leg pain ($p<0.05$) (Table 5). These analytical results are shown as a path diagram in Figure 1. With respect to leg pain on resumption of activity and on discharge, we performed an additional hierarchical multiple regression analysis to search for background factors. Leg pain on resumption of activity and on discharge were treated as dependent variables and the independent variables were all the items that were not identified on resumption of activity and on discharge shown in Table 5, for each follow-up period. The results identified leg numbness as a significant factor on resumption of activity, and leg numbness and back pain as significant factors on

Table 4. Back pain, leg pain, leg numbness, ODI score, and ODI sub-scores (before surgery, resumption of activity, discharge, and return visit)

	before surgery				resumption of activity				discharge				return visit			
	mean	SD	median	quartile range	mean	SD	median	quartile range	mean	SD	median	quartile range	mean	SD	median	quartile range
back pain (mm)	48.0	31.6	53.0	57.0	17.7^{*}	20.3	10.0	24.0	$8.9^{*\dagger}$	14.5	3.0	10.0	$10.6^{*\dagger}$	18.5	3.0	10.0
leg pain (mm)	57.8	27.4	62.0	36.5	12.9^{*}	17.8	4.0	18.0	$9.2^{*\dagger}$	15.2	3.0	14.5	$7.5^{*\dagger}$	14.9	0.0	7.0
leg numbness (mm)	47.6	27.8	50.0	44.5	12.8^{*}	18.5	6.0	19.5	$8.9^{*\dagger}$	14.7	3.0	12.0	$6.9^{*\dagger}$	11.9	1.5	8.3
ODI sub-score (points)																
pain intensity	2.4	0.9	2.0	1.0					0.8^{*}	0.6	1.0	1.0	0.9^{*}	0.7	1.0	0.0
personal care	1.4	0.8	1.0	1.0					0.9^{*}	0.9	1.0	1.0	$0.6^{*\#}$	0.7	0.0	1.0
lifting	2.0	1.1	2.0	2.0					2.1	1.4	2.0	2.0	$1.6^{*\#}$	1.3	1.0	2.0
walking	1.4	1.1	1.0	1.0					0.6^{*}	0.7	0.0	1.0	$0.4^{*\#}$	0.6	0.0	1.0
sitting	2.1	1.1	2.0	2.0					1.4^{*}	0.9	1.0	1.0	$1.1^{*\#}$	0.8	1.0	1.0
standing	2.3	1.3	2.0	3.0					1.0^{*}	1.1	1.0	1.0	$0.7^{*\#}$	0.9	0.5	1.0
sleeping	1.3	1.2	1.0	0.0					0.4^{*}	0.7	0.0	1.0	$0.1^{*\#}$	0.5	0.0	0.0
social life	2.2	1.2	2.0	2.0					1.1^{*}	1.0	1.0	2.0	$0.9^{*\#}$	1.0	1.0	2.0
traveling	2.0	1.2	2.0	2.0					1.1^{*}	1.1	1.0	2.0	$0.7^{*\#}$	0.8	1.0	1.0
ODI score (%)	39.8	17.3	37.8	24.4					21.1^{*}	13.1	22.0	19.5	20.1^{*}	13.6	19.0	17.7

SD: Standard Deviation, back pain, leg pain, and leg numbness: Visual Analogue Scale, * :p<0.05 (VS before surgery), †: p<0.05 (VS resumption of activity), #:p<0.05 (VS discharge)

Table 5. Factors affecting the ODI score one month postoperatively (before surgery, resumption of activity, discharge)

1) before surgery

	standardized partial regression coefficient	p-value
profession (desk work)	0.294	0.01
back pain	0.238	0.02

2) resumption of activity

	standardized partial regression coefficient	p-value
leg pain	0.277	0.00

3) discharge

	standardized partial regression coefficient	p-value
ODI score	0.737	0.00
ODI sub-score traveling	-0.360	0.01
leg pain	0.225	0.01

discharge ($p<0.05$). A principal component analysis was also carried out to assess the component factors of the ODI score on discharge. The ODI traveling and sitting sub-scores shown in the path diagram had the greatest component loading in the first principal component.

DISCUSSION

This study demonstrated good improvement in the ODI score on return visit by patients who underwent lumbar discectomy compared with their preoperative scores. Preoperative and early postoperative factors contributing to the ODI score on return visit were also identified.

As shown in the path diagram, six parameters were identified by multivariate regression analysis as factors contributing to the ODI score on return visit. Among these, leg numbness on resumption of activity and on discharge and back pain on discharge, identified by hierarchical multiple regression analysis, had an indirect influence on the ODI score on return visit. Back pain was also identified by multiple regression analysis as a preoperative relative factor. Because back pain in LDH patients involves multiple factors, including nerve roots, intervertebral discs, muscles/fascia, and psychological/social elements, its limitation to nerve root decompression alone is indicated[22, 23]. With respect to the preoperative back pain identified by multivariate regression analysis, working on the hypothesis that nerve root problems were resolved by decompression, it could be construed that discogenic, muscular/fascial, and psychological/social elements may persist postoperatively,

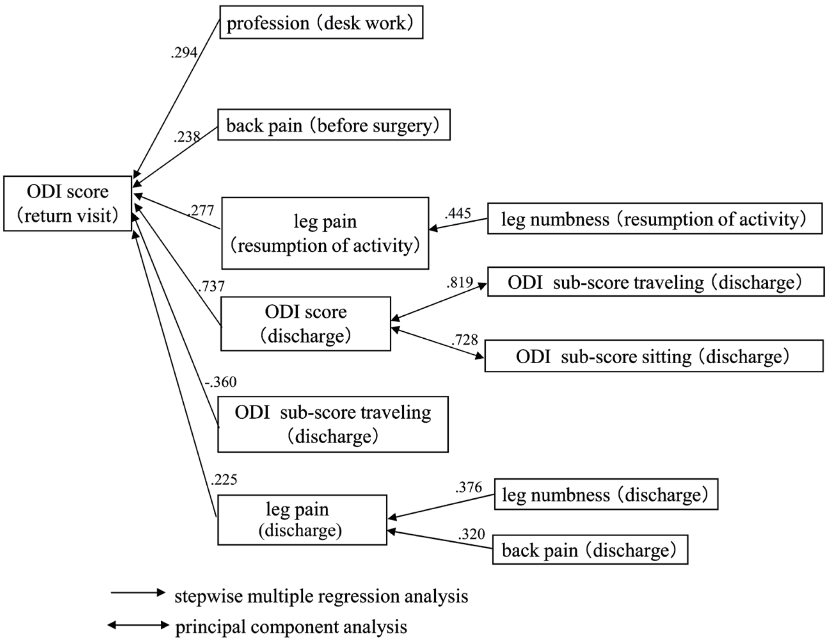

Fig. 1. Path diagram (Factors affecting the ODI score one month postoperatively)

and that their influence may have surfaced in accordance with postoperative improvements in activity. Numazawa et al.[24], reported that the duration of hospitalization was longer in patients with residual symptoms, while Sato et al.[25], stated that residual leg and back pain were the factors most associated with patient satisfaction concerning treatment. Residual symptoms after surgery such as leg pain and numbness and back pain may, therefore, influence patient satisfaction, thereby affecting the ODI score as a patient-based evaluation of QOL.

Our principal component analysis results also imply that the ODI traveling and sitting sub-scores, are major contributors to the ODI score on discharge, a factor identified by multiple regression analysis. Sitting posture is common to the factors of profession (desk work) and the ODI traveling sub-score. Travel may conceivably involve both sitting and standing but according to census data on methods of commuting to work[26], about half or more of respondents use their own car, with 9% traveling by bicycle or motorbike, and only around 12% of the total travel by bus or train, in which they might have had to stand. This means that the image of travel held by most respondents is of traveling while seated. As mentioned earlier, this identification of sitting posture is consistent with previous reports that sitting poses a high degree of difficulty for patients with poor outcomes following lumbar discectomy.[1] According to Nachemson et al.[27], sitting imposes a higher amount of pressure than lying supine or standing, and pressure is also higher in the anteflexion position (which reduces lumbar flexure) than in the intermediate position. Mannion et al.[28], stated that physiological anteflexion of the lumbar spine was markedly reduced 2 months after lumbar decompression, with flattening of the spine. In the present study, the VAS score for back pain and the ODI pain sub-score both worsened on return visit compared with on discharge, although these differences were not statistically significant. It can therefore be conjectured that although removal of the herniated mass did result in decompression, an excessive increase in intradiscal pressure due to flattening of the lumbar spine after surgery was imposed on top of the intervertebral disc distortion and damage due to surgical invasion. The result was an induction of discogenic back pain which contributed to the patient's difficulty in sitting. Intervertebral disc nutrient supply and waste removal also occurs via diffusion and fluid flow, and maintenance of physiological intradiscal pressure is important from the perspective of the proteoglycan synthesis ability, which forms the disc substrate[29]. It is possible that increased intradiscal pressure caused by flattening of the lumbar spine may also inhibit these mechanisms. Konno et al.[30], investigated intramuscular pressure in back muscles in different postures, and reported that intramuscular pressure was highest in the anteflexion position, followed by the intermediate position, and the retroflexion position in both sitting and standing. This suggests that for intervertebral discs, increased intramuscular pressure of the back muscles due to surgical invasion and flattening of the lumbar spine may induce muscular/fascial back pain, which would also affect the degree of difficulty in sitting. In light of these points, it is thought to be important to take into account both residual symptoms, such as leg pain/numbness and back pain, and sitting posture in early physiotherapy after lumbar discectomy.

Physical therapy has been reported as an effective form of physiotherapy for residual symptoms[31, 32]. If the characteristics of the physical actions used in physical therapy are sufficiently taken into account, there are almost no side effects or pain when practiced, and the sense of comfort generated by an appropriate degree of stimulation makes it an extremely popular form of therapy in clinical practice[31]. Ishida et al.[32], have demonstrated the effectiveness of early postoperative ultrasound therapy for residual leg symptoms, reporting that this was effective in both the short and long terms. Puolakka et al.[16], also stated that leg pain 2 months postoperatively was a risk factor for increasing the number of sick leave days within 5 years postoperatively. This implies that early postoperative leg pain may be a factor in poor long-term prognosis. Physical therapy, particularly ultrasound therapy, should therefore be used proactively to treat residual symptoms after lumbar discectomy from an early stage.

For sitting comfort, chairs with an angle of 110° between the backrest and the seat that provide lumbar support have been reported as the most effective at reducing intradiscal pressure and alleviating back muscle tension[33–39]. Wilke et al.[38], stated that from the perspective of intravertebral disc nourishment, frequent changes of position are more important than alleviating intradiscal pressure. Lumbar continuous passive motion (CPM) has also been reported to improve back pain, tiredness, and gluteal numbness when sitting down[39]. This suggests the importance of guidance for each patient that takes their individual living environments and social aspects into account. In terms of physical aspects, there have also been reports that lumbar spine and hip joint mobility and trunk muscle strength training are important from an early stage following lumbar discectomy[40]. Early physiotherapy following lumbar discectomy should, therefore, not only include exercise therapy, with the goal of functional improvement, but also include guidance on sitting posture.

In addition, as stated earlier, numerous reports have indicated that a poor early postoperative ODI score is a risk factor for long-term postoperative prognosis following lumbar discectomy. In light of our present findings, it can therefore be inferred that physiotherapy tailored to the degree of difficulty of individual activities of daily living is important for patients with poor ODI scores on discharge, and continued intervention after discharge should also be considered.

One limitation of this study was the short postoperative follow-up period. In addition, as the only dependent variable used on return visit was the ODI score, our results may be highly biased in terms of assessing patient QOL. Further studies evaluating QOL by other scales, such as the widely used RMDQ and SF-36, are required. Another limitation was that a multifaceted evaluation incorporating psycho-mental elements was lacking from the present study. Nevertheless, this study is one of only a few to have focused on the postoperative ODI score in Japan, and its findings will be useful for the practice of postoperative physiotherapy.

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