

Multivariate Analysis of Factors that Influence the Clinical Outcome Oswestry Disability Index in Patients with Lumbar Spinal Stenosis Post Percutaneous Stenoscopic Lumbar Decompression

Ahmad Fauzi^{1*}, Asrafi Rizki Gatam², Harmantya Mahadipta³, Phedy², Ajiantoro², Riza Aprizal⁴ and Luthfi Gatam²

¹Department of Orthopaedic Surgery, Medical Faculty of Lampung University,

²Department of Orthopaedic Surgery, Fatmawati Hospital, Jakarta, Indonesia.

³Department of Orthopaedic Surgery, Tangerang Regional Public Hospital, University of Indonesia.

⁴Department of Orthopaedic Surgery, Pasar Rebo Regional Public Hospital, Jakarta, Indonesia.

*Corresponding author Email: ahm4d.fauz1@gmail.com

<https://dx.doi.org/10.13005/bpj/2125>

(Received: 10 July 2020; accepted: 29 December 2020)

This study aimed to assess the factors that influence The Oswestry Disability Index (ODI) clinical outcomes in patients with Lumbar Spinal Stenosis (LSS) after Percutaneous Stenoscopic Lumbar Decompression (PSLD). A total of 92 patients were analyzed for factors that affecting ODI clinical outcome. These factors were age, sex, body mass index, cigarette consumption, alcohol consumption, sports history, pain onset, radicular pain, VAS pain score, paresis and paresthesia symptoms, duration and conservative management, length of operation, duration of treatment, recurrence of pain, and duration of postoperative healing. Data were collected by direct examination, questionnaires, in-depth interviews, and patient medical records. A Pearson correlation or Spearman Rank test and independent T-test or Mann Whitney was conducted to determine the significant relationship between these factors and ODI clinical outcomes. Multiple linear regression was performed to find out which factor most influences ODI clinical outcome. Some factors influence ODI outcome in the sample as resulted by statistical analysis. From the statistic analysis, only three factors that influence the ODI postoperative there was age ($p=0.003$), VAS preoperative ($p=0.001$), and ODI preoperative ($p=0.001$). There was no statistical significance found in the other factors with $p>0.005$. Factors influencing clinical outcomes by ODI in patients with lumbar spinal stenosis after PSLD was the age of the patient, preoperative ODI, and preoperative VAS.

Keywords: Clinical outcome, Percutaneous stenoscopic lumbar decompression, Oswestry disability index, Lumbar spinal stenosis.

Lumbar Spinal Stenosis (LSS) is a condition of narrowing the spinal canal or intervertebral foramen in the lumbar region, accompanied by the pressure of nerve roots coming out of the foramen¹. It is believed there are 5 out of 1,000 people over the age of 50 are suffering

from this disease. It is the most common disease that requires spinal surgery in people over 60 years old^{2,3}.

Indications of surgery on LSS are neurological symptoms that get heavier, progressive neurological deficits, decreased quality of life due

to disruption of daily activities, and failure of conservative therapy⁴. The most common treatment procedure is decompression laminectomy. That treatment aims to decompress the nerve root with various techniques to reduce symptoms in the lower limbs. There are currently many minimally invasive procedures that can be performed, one of which is very popular is to use endoscopic spine surgery, such as the percutaneous stenoscopic lumbar decompression method (PSLD). Endoscopic spine surgery can reduce postoperative pain incidence by minimizing muscle damage around the spine and preventing instability⁵⁻⁸.

The Oswestry Disability Index (ODI) is one of the clinical outcomes for evaluating the success of lower back pain management^{9,10}. ODI is in the form of a questionnaire and has been tested for validity, reliability, and has become the primary choice in assessing patients' clinical outcomes with lower back problems¹¹. Based on studies conducted by Vianin *et al.*,¹¹ it is said that ODI is a valid, reliable questionnaire and is a responsive specific condition check tool that is suitable for use in clinical practice. ODI shows good validity, acceptable internal consistency, test-retest reliability, and low administrative complexity^{11,12}.

This study was conducted to assess the predictive factors affecting ODI clinical outcomes in Lumbar Spinal Stenosis patients after PSLD treatment. These factors were age, sex, body mass index, cigarette consumption, alcohol consumption, exercise history, pain onset, radicular pain, VAS pain score, paresis and paresthesia symptoms, duration and conservative management, length of operation, duration of treatment, recurrence of pain, and duration of postoperative healing.

METHODS

Study design

This study was an observational analytic study with a cohort design of LSS patients undergoing PSLD at the Premiere Bintaro Hospital, Tangerang, from January 2016 - January 2019. The inclusion criteria were patients diagnosed with Lumbar Spinal Stenosis without instability, both men and women, who received PSLD treatment. All patients involved did not get another surgical procedure and did not have other complicated diseases in the spinal area. In total, 92 patients

met these criteria. All patients involved had signed informed consent for approval to take part in the study. The study was approved by the Health Research Ethics Committee, Faculty of Medicine, University of Lampung.

Patient data were obtained through direct examination, questionnaires, in-depth interviews, and patient medical record data. Before surgery, these patients were interviewed in-depth to find out factors related to demographics and clinical factors. Demographic factors include age, sex, weight, height, BMI, cigarette consumption, alcohol consumption, and sports history. Clinical factors include pain onset, presence or absence of radicular pain, VAS score, and the presence or absence of paresthesias and paresis symptoms. Patients were also examined for their IDO scores using a questionnaire tested for validity and reliability. The ODI questionnaire was divided into ten groups of questions with 0-5 per section. A score of 5 indicates the most severe disability. The index will be calculated by adding up all the values divided by 50 and multiplying by 100%.¹²

After that, LSS patients underwent surgery with the PSLD method using the stenoscope (*a 12 o stenoscope*). This procedure was performed on one incision made. At first, the patients were anesthetized epidurally, then placed supine. The incision is then made vertically 7 mm long at a location that has been confirmed by prior intraoperative fluoroscopic guidance. Furthermore, the blunt dilator was inserted right next to the spinous process next to the ipsilateral at right angles to the lamina. The working sleeve was inserted into the dilator; then, the rigid angle stenoscope was inserted through the other side through the working sleeve⁴. Then a laminotomy was performed to expose the outermost portion of the ligamentum flavum. After that, ipsilateral decompression is performed to remove the contralateral ligament and superior articular process to decompress the contralateral transverse nerve root. After surgery, the patient was re-examined for VAS and IDO scores and outcome factors, such as the recurrence of pain, duration of operation, duration of treatment, and postoperative healing duration.

Data Analysis

All data were analyzed using the Pearson correlation test or the Spearman Rank test and the independent T-test or Mann-Whitney test.

Furthermore, the Linear Regression Multivariate test is performed on factors that have a p-value <0.2. Data about the time of recurrence of pain is used as a reference in conducting survival analysis. The data is displayed in units per month and has a maximum range of up to 1 year postoperatively according to the longest follow-up time.

RESULTS

General Characteristics

In this study, the average age of the sample was 60.8 (45-78) years. There are more women than men, with a male: female ratio of 1: 1.3. The majority of the sample, not smoking (72.8%), did not consume alcohol (91.3%), and rarely exercise

(81.5%). The sample averaged pain onset at month 48 months, with mean preoperative VAS and IDO values of 4.5 and 42.5. The majority of samples had paresthesias symptoms (91.3%) but did not have paresis symptoms (86.9%).

Relationship between Demographic Factors and IDO Score Change

From 7 demographic factors associated with IDO score change, only the age was known to have a significant relationship with IDO scores on the first day to 12 months postoperatively. Bodyweight did not have a significant relationship with IDO scores change on the first day, three months, and 12 months postoperatively, but at six months postoperatively, weight had a significant relationship with sample IDO scores. BMI did

Table 1. Characteristic of the 92 patients with LSS after PSLD

Patient Characteristic	Values
Ages, years - means (SD)	60.8 (45-78)
Sex	
Male	40 (43.5%)
Female	52 (56.5%)
Weight, kg - means (SD)	75.4 (55-92)
Height, cm - means (SD)	165.5 (155-181)
Body Mass Index, kg/m ² - means (SD)	25.7 (18.1-37.7)
Cigarette Consumption	
No	67 (72.8%)
Yes	25 (27.2%)
Exercise History	
Rarely	75 (81.5%)
Frequently	17 (28.5%)
Pain Onset, month - means (SD)	48 (1-128)
Radicular Pain	
No	7 (7.7%)
Yes	85 (92.3%)
Paresthesias Symptoms	
No	8 (7.7%)
Yes	84 (91.3%)
Paresis Symptoms	
No	80 (86.9%)
Yes	12 (13.1%)
Length of Operation, minute - means (SD)	64 (43-140)
Duration of Treatment, days - means (SD)	1.5 (2-4)
Pain Recurrences	
No	86 (93.5%)
Yes	6 (6.5%)
Duration of Postoperative Healing, days - means (SD)	6 (2-40)

not significantly correlate with changes in sample IDO scores on the first day after surgery, but BMI was significantly related to IDO scores change in subsequent measurements. Height did not have a significant relationship with changes in sample IDO scores, either on all measurements (Table 2).

Regarding sex, there were significant differences in changes in IDO scores between men and women on the first day postoperatively. In subsequent measurements, there were no significant differences in changes in IDO scores between men and women. There were no significant differences

in IDO scores on factors such as smoking history, alcohol consumption, and exercise history throughout the measurements (Table 3).

Relationship between Clinical Factors and IDO Score Change

From 7 clinical factors associated with IDO score change, only VAS and preoperative IDO scores were significantly associated with IDO scores change from the first day to 12 months postoperatively. Pain onset was associated with IDO score change at 3, 6 and 12 months postoperatively, whereas rehabilitation duration

Table 2. The correlation of age, weight, height, and BMI with IDO score change

Demographic Factors	IDO Score Change (p-value)							
	1 st day		3 rd month		6 th month		12 th month	
	R	P	R	p	R	P	r	p
Age	-0.228	0.014*	-0.480	0.011*	-0.564	0.004*	-0.677	0.003*
Weight	0.245	0.165	0.155	0.155	0.175	0.030*	0.090	0.350
Height	0.345	0.165	0.175	0.155	0.245	0.154	0.270	0.350
BMI	-0.127	0.080	-0.233	0.025*	-0.259	0.010*	-0.292	0.001*

Exp: The p-value was calculated based on the Pearson correlation test at a 5%. * indicates a significant relationship.

Table 3. IDO score changes based on gender, cigarette consumption, alcohol consumption, and exercise history

Demographic Factors Sex	Mean IDO Score		Mean Difference (IK95%)	P
	Male(N=40)	Female(N=52)		
1 st day postoperatively	46 (8 - 80)	40.5 (2 - 70)	3.65 (-0.11 - 7.21)	0.025*
3 months postoperatively	50 (10 - 82)	42 (18 - 80)	0.377 (-3.14 - 3.7)	0.454
6 months postoperatively	50.5 (10 - 83)	46 ± 7.6	0.95 (-2.51 - 4.3)	0.565
12 months postoperatively	52 ± 5.86	49.4 ± 6.4	1.5 (-1.1 - 3.7)	0.345
Cigarette Consumption	No(N=67)	Yes(N=25)		
1 st day postoperatively	44 (2 - 52)	45.5 (8 - 60)	-0.835 (-5.0 - 3.4)	0.525
3 months postoperatively	46.5 ± 6.2	42 (10 - 75)	1.95 (-1.9 - 5.8)	0.333
6 months postoperatively	48.6 ± 7.1	43.5 (10 - 87)	0.89 (-3.1 - 4.7)	0.676
12 months postoperatively	51.4 ± 6.2	49.6 ± 5.86	-0.75 (-3.6 - 1.9)	0.635
Alcohol Consumption	No(N=84)	Yes(N=8)		
1 st day postoperatively	46.5 (2 - 78)	44.5 (8 - 70)	4.78 (-3.89 - 13.1)	0.456
3 months postoperatively	46.9 (10 - 80)	43.5 (10 - 68)	6.56 (-1.7 - 13.7)	0.345
6 months postoperatively	48.9 ± 8.2	47.5 (12 - 50)	5.88 (-2.4 - 13.1)	0.787
12 months postoperatively	51.5 ± 6.14	50.7 ± 4.9	2.76 (-2.9 - 8.2)	0.245
Exercise History	Rarely(N=81)	Frequently(N=18)		
1 st day postoperatively	37.5 (2 - 42)	45.5 (2 - 80)	-1.666 (-5.7 - 2.42)	0.070
3 months postoperatively	44.5 (10 - 56)	45.9 (10 - 49)	-6.87 (-4.3 - 3.14)	0.675
6 months postoperatively	45.7 ± 8.2	49.7 (12 - 52)	-1.35 (-5.33 - 2.8)	0.545
12 months postoperatively	49.4 ± 6.3	51.9 ± 5.39	-1.75 (-4.6 - 0.67)	0.235

Exp: The p-value was calculated based on the independent T-test and Mann Whitney at a 5%. * indicates a significant relationship

before surgery is only associated with IDO scores on the first postoperative day. However, subsequent measurements at month 3rd through month 12th, the length of rehabilitation before surgery did not show any significant relationship with changes in IDO scores (Table 4).

There was no significant difference in IDO score change due to radicular pain and paresis symptoms on the first day to 12 months postoperatively. In the symptoms of paresthesias, differences in IDO score change only occur on the first day postoperatively, whereas in subsequent measurements up to 12 months postoperatively, no significant difference in IDO score change was found (Table 5).

Relationship between Outcome Factors and IDO Score Change

From 4 outcome factors studied, only pain recurrence factors had a significant relationship with IDO score change from the first day to 12 months postoperatively. Other factors, such as duration of operation, duration of treatment, and postoperative healing duration, were not related to IDO score change, both on the first day to 12 months postoperatively (Table 6 and 7).

Survival Analysis

Based on the survival test that has been done, it is known that only 12.7% of patients experience recurrence of pain in the first year, while 93.5% of the remaining patients do not experience

Table 4. Correlation of pain onset, preoperative VAS and IDO score and duration of rehabilitation with IDO score change

Clinical Factors	IDO Score Change (p-value)							
	1 st day		3 rd month		6 th month		12 th month	
	R	P	R	P	R	P	R	P
Pain Onset	0,140	0,687	0,171	0,050*	0,191	0,016*	0,365	0,001*
Preoperative VAS	-0,354	0,001*	-0,375	0,001*	-0,476	0,001*	-0,655	0,001*
Preoperative IDO	0,576	0,001*	0,657	0,001*	0,657	0,001*	0,799	0,001*
Duration of Rehabilitation	-0,245	0,015*	-0,088	0,575	-0,458	0,787	0,671	0,216

Exp: The p-value was calculated based on the Pearson correlation or Spearman Rank test at á 5%. * indicates a significant relationship

Table 5. IDO score change based on radicular pain, paresis and paraesthesia symptoms

Clinical Factors	Mean IDO Score		Mean Difference (IK95%)	P
	No(N=7)	Yes(N=85)		
Radicular Pain				
1 st day postoperatively	45 ± 3.5	39 (2 - 60)	3.47 (-7.4 - 14.3)	0.687
3 months postoperatively	48.9 ± 3.6	45 (10 - 68)	5.84 (-4.1 - 15.8)	0.454
6 months postoperatively	49.5 ± 2.6	46.7 ± 8.7	5.72 (-4.3 - 15.7)	0.454
12 months postoperatively	52.5 ± 4.04	49.77 ± 6.13	3.5 (-3.5 - 10.6)	0.245
Paraesthesia Symptoms	No(N=21)	Yes(N=81)		
1 st day postoperatively	38 (2 - 50)	42 (2 - 60)	-6.06 (-10.6 - -1.67)	0.001*
3 months postoperatively	45 (10 - 60)	41 (10 - 64)	-1.1 (-5.3 - 3.05)	0.657
6 months postoperatively	49 (10 - 54)	48 ± 7.6	-2.2 (-6.4 - 1.9)	0.387
12 months postoperatively	51.4 ± 6.59	50.01 ± 6.0	0.12 (-3.1 - 3.3)	0.823
Paresis Symptoms	No(N=80)	Yes(N=12)		
1 st day postoperatively	30 (2 - 42)	32.5 (14 - 40)	-1.80 (-6.6 - 3.01)	0.631
3 months postoperatively	41.2 (10 - 54)	40 (16 - 56)	-0.82 (-5.6 - 3.9)	0.795
6 months postoperatively	44.5 ± 8.8	42.9 ± 7.5	-0.543 (-4.9 - 3.9)	0.809
12 months postoperatively	50.09 ± 5.85	45.6 ± 7.34	0.69 (-2.5 - 3.8)	0.665

Exp: The p-value was calculated based on the independent T-test and Mann Whitney at á 5%. * indicates a significant relationship.

Table 6. Correlation of duration of operation, duration of treatment and duration of postoperative healing with IDO score change

Outcome Factors	IDO Score Change (<i>p-value</i>)							
	1 st day		3 rd month		6 th month		12 th month	
	R	<i>p</i>	R	<i>P</i>	R	<i>P</i>	R	<i>P</i>
Duration of Operation	-0.175	0.145	-0.222	0.148	-0.105	0.375	-0.245	0.558
Duration of Treatment	-0.225	0.875	-0.175	0.574	-0.165	0.107	-0.295	0.125
duration of healing	-0.224	0.454	-0.185	0.241	-0.193	0.272	-0.159	0.592

Exp: The *p*-value was calculated based on the Spearman Rank test at á 5%. * indicates a significant relationship.

Table 7. IDO score change based on pain recurrence

Outcome Factors Pain Recurrence	Mean IDO Score		Mean Difference (IK95%)	<i>P</i>
	No(N=7)	Yes(N=85)		
1 st day postoperatively	40 (12 - 50)	38.7 (2 - 60)	15.38 (10.78–19.99)	0.001*
3 months postoperatively	44.5 ± 6.5	40.1 (10 - 62)	11.5 (6.9 – 16.01)	0.001*
6 months postoperatively	48.7 ± 5.7	45.6 (10 - 64)	13.7 (9.4 – 18.03)	0.001*
12 months postoperatively	50.55 ± 5.6	47 ± 7.7	4.5 (1.1 – 8.1)	0.011*

Exp: The *p*-value was calculated based on the independent T-test and Mann Whitney at á 5%. * indicates a significant relationship

pain recurrence in the first year. The pain recurrence time experienced by patients varies from month 1st to month 12th (Figure 1).

The results of the Cox Regression test showed that there were no significant relationships between the five variables that affected the change in IDO scores 12 months postoperatively, i.e., age, BMI, the onset of pain, VAS and IDO preoperatively, with pain recurrence ($p > 0.05$) (Table 8). Therefore, the hazard ratio obtained from the Cox regression statistical test cannot be interpreted.

DISCUSSION

Percutaneous Stenoscopic Lumbar Decompression (PSLD) is an alternative method of lumbar stenosis therapy. This method provides more advantages than the open discectomy method, including smaller incision wounds, better cosmetics, premature ambulation, lighter postoperative pain, less blood loss during surgery, short duration of treatment, and shorter analgesic dose lower, shorter return to activities and thus lower maintenance costs^{13,14}. Besides, better long-

term outcomes are also the reason this method is used in this study.

Based on this research, three factors most influence the change in IDO scores in LSS patients undergoing PSLD therapy, namely age, preoperative VAS score and preoperative IDO score. Age is one of the factors that influence changes in IDO scores. The strongest correlation to change in IDO scores was 12 months rather than one day, three months, or six months postoperatively. In this study, the age factor can influence long-term clinical outcomes in Lumbar spinal stenosis patients who performed the PSLD procedure. Age is one factor that affects the general condition of the spine, both intervertebral discs, degeneration and thickening of the facet joints and thickening of the ligamentum flavum. It is known that notochord cells, stem cells in the intervertebral discs, begin to decrease at the age of 15 years, and degeneration in the intervertebral discs has occurred at that time only slightly^{15,16}. In other words, the older the patient is, the recovery ability of the intervertebral discs will deteriorate. This change will result in complaints due to the lumbar canal's narrowing, suppressing the nerve fibers. It might explain the

relationship between increasing age with changes in IDO scores declining in this study's results. This result is supported by other studies conducted by Boden *et al.*, That in patients who are already degenerative, this does not only occur in the spine but also in other places, especially in the hip joint and knee joint¹⁷.

Besides age, VAS and IDO scores before surgery also significantly affect changes in IDO scores. VAS or Visual Analog Scale is

a psychometric response scale for subjective characteristics or attitudes that cannot be measured directly and is often used to evaluate pain in patients with lumbar spinal stenosis. This VAS has proven to be sensitive and can be repeated, but it is not specific enough for lumbar spinal stenosis. Some studies still use VAS to estimate the severity of pain and intervene according to the patient's condition. A numerical system can be used with VAS, where one will show no pain, and ten will

Table 8. Survival analysis with variables related to changes in IDO 12 months postoperatively

Variable	Pain Recurrence		Total	p-value	HR (IK 95%)	p-value	aHR (IK 95%)
	No N (%)	Yes N (%)					
Age							
< 46 years	33 (83%)	7 (17%)	40	0.273 ^{e)}	0.543		
≥ 46 years	46 (88%)	6 (12%)	52				
VAS Preoperation							
< 5	10 (90%)	5 (10%)	15	0.845 ^{e)}	1.238		
≥ 5	71 (92%)	6 (8%)	77				
IDO Preoperation							
< 55	43 (86%)	7 (14%)	50	0.541 ^{e)}	0.714		
≥ 55	36 (85%)	6 (15%)	42				
BMI							
< 25	37 (90%)	4 (10%)	41	0.437 ^{e)}	1.769		
≥ 25	42 (82%)	9 (18%)	51				
Pain Onset							
< 36 Months	38 (88%)	5 (12%)	43	0.756 ^{e)}	1.312		
≥ 36 Months	41 (84%)	8 (16%)	49				

Results are displayed in the Hazard Ratio value^{e)} p-value calculated by *Cox Regression test*.

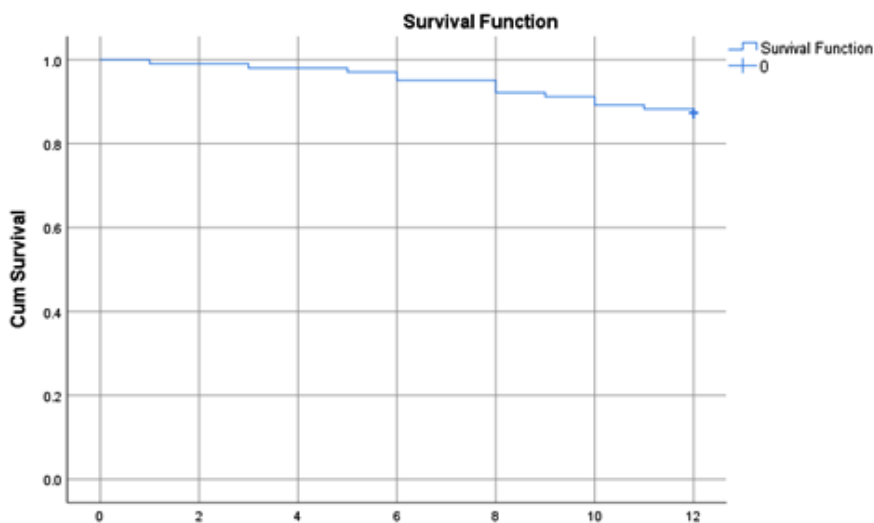


Fig. 1. Kaplan Meier Chart

show the worst possible pain^{18,19}. Patients with high VAS will show a lower IDO value than patients with lower VAS because the VAS value will affect the patient's clinical outcome.

Our study also found that preoperative IDO scores could be one of the factors that could influence changes in IDO scores 12 months postoperatively. The greater the IDO score before surgery, the more significant the change in IDO scores 12 months postoperatively.

This study's survivability test did not show any relationship between the predicted factors of changes in the 12-month IDO score to the pain recurrence pain in LSS patients after PSLD. It is possible because the follow-up period is only limited to 1 year postoperatively. Patients without recurrence of pain one year after surgery in this study were still likely to experience the event for a longer time. If the follow-up is continued for a longer time, it will undoubtedly significantly affect the proportion of patients who experience recurrence of pain.

CONCLUSION

There are three factors that most influence changes in 12 months IDO score in LSS patients undergoing PSLD therapy, namely age, preoperative VAS score and preoperative IDO score.

Conflict of interest

The author declares no conflict of interest.

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