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A prospective study analyzing the clinical outcome of degenerative lumbar canal stenosis treated by laminectomy

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Abstract

BACKGROUND: Degenerative lumbar canal stenosis is a common disease occurring and one of the common indications for spine surgery in elderly. There are many objective measures such as neurological deficits, Japanese Orthopaedic Association score, and radiological evaluation to analyze the clinical outcome. Spinal surgeries are performed to improve the quality of life and to prevent long-term disabilities; hence self-assessing subjective measures are required to accurately assess the clinical outcome. Self-assessed subjective methods for assessing the quality of life are Oswestry disability index (ODI), self-paced walk test (SPWT), and visual analogue score (VAS).

AIM OF THE STUDY: The aim of the study was to assess the clinical outcome using self-assessed subjective methods, namely, self-ODI score, SPWT score, and VAS for the back and leg.

SETTING AND STUDY DESIGN: We performed a prospective study of a surgical outcome of lumbar canal stenosis using subjective methods.

MATERIALS AND METHODS: Fifty patients diagnosed clinically with degenerative lumbar canal stenosis having ODI score of more than 40 and failed conservative surgery were evaluated with the magnetic resonance imaging of spine before undergoing surgical decompression. Preoperative self-assessed subjective measures ODI score, SPWT score, and VAS were compared with 12 months' postoperative scores.

STATISTICAL ANALYSIS USED: Statistical methods used for the analysis were dependent t test, Wilcoxon matched paired test, and Spearman's rank correlation method.

RESULTS: The mean preoperative ODI score was 57.3 and postoperative was 7.4. The mean SPWT distance was 124.9 meters preoperatively and 1482.0 meters postoperatively.

CONCLUSION: We conclude that surgical decompression for degenerative lumbar stenosis gives good clinical results in terms of patient's quality of life as suggested by improved postoperative ODI score, SPWT distance, and VAS compared with preoperative scores.

Keywords:

Laminectomy, lumbar canal stenosis, Oswestry disability index, self-paced walk test, visual analogue score

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Background

Decompression for degenerative lumbar canal stenosis is a common surgery done in orthopedic practice. Lumbar canal stenosis can be treated both non surgically and surgically. But the results of surgical treatment are better than non surgical one. Weinstein *et al.* concluded in their study surgical treatment has better outcome compared to non surgical.[1] There are many objective measures to study the clinical outcome after spine surgery such as neurological deficit assessment, radiological measures, and Japanese Orthopaedic Association (JOA)

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scoring. The pathogenesis of lumbar canal stenosis has been well studied by Kirkaldy-Willis in the cadavers. The changes noted in posterior facetal joints and disc causes entrapment of spinal nerves in the lateral recess and spinal canal.[2] Young age, obesity, worse bodily pain, and lateral recess stenosis were considered as poor prognostic factors. Most of the modern spine surgeries are done not only to alleviate pain but also to improvise the quality of life. Hence we require subjective measures to assess the clinical outcome after spine surgery. Patient's self-assessed subjective measures include Oswestry disability index (ODI) score, self-paced walk test (SPWT), and visual analogue score (VAS). Fairbank has revised the oswestry disabilty questionnaire in 2000.[3] Previous studies have proved the ODI score is a simple, reliable, easy patient comprehensive and compliance tool. Although non-spinal problems are prevalent in the elderly but spinal symptoms were the most important correlate of reduced functional status.[4] Katz *et al.* also insisted upon the need for subjective methods for assessing the outcome after decompression for lumbar canal stenosis. According to him patients' assessment of their own health and comorbidity are the most cogent outcome predictors.[5] Atlas *et al.* also concluded surgical treatment had better outcome but decision making approach should be shared between treating surgeon and the patient when considering treatment potions.[6] Amundsen *et al*. were also of the same conclusion that surgical management had better outcome compared to non surgical.[7,8] The purpose of this study was to analyze the clinical outcome after decompression for degenerative lumbar canal stenosis using subjective measures. Studies done regarding the correlation of radiological magnetic resonance imaging (MRI) findings with the clinical severity of spinal stenosis suggest varied relationship. Hence, proper preoperative clinical subjective assessment and radiological assessment, MRI, to look for levels, severity of stenosis, and instability is necessary for a good functional outcome. We desired to study the functional outcome of decompression for degenerative lumbar canal stenosis using subjective measures, namely, ODI score, SPWT distance, and VAS for the leg and back pain. We also studied the correlation between the MRI findings with clinical findings. The statistical correlation between MRI and ODI, MRI and SPWT, MRI and VAS was done. Laminectomy is the most basic surgery done in lumbar canal stenosis.[9] Conventional laminectomy removes the posterior elements including lamina, spinous process, and posterior ligaments.[10]

Materials and Methods

We obtained institutional ethical board committee approval. We collected the data on consecutive patients. Patients' data on ODI score, SPWT distance, VAS grading, and MRI severity grading were obtained as routine care of the patients. We included 50 patients aged between 30 and 77, with a mean age of 56.5 years. All patients underwent preoperative evaluation of ODI score, SPWT distance, and VAS for the leg and back pain. According to the ODI scores, the disability is divided into four grades: minimal (0–21), moderate (20–40), severe (40–60), and crippled (60–80). The SPWT was classified as poor with distance <100 meters, fair with distance between 100 and 800 meters, good with distance between 800 and 1500 meters, and very good with walking distance more than 1500 meters. We included patients with preoperative ODI score of more than 40, failed conservative trial, and having moderate-to-severe claudication pain indicated by SPWT distance ranging from 78 to 1500 meters. All patients were evaluated with dynamic radiographs of lumbar spine to rule out instability and with MRI whole spine. The MRI grading of the severity of the lumbar stenosis was done based on Lee *et al.* scoring system. Lee *et al.* classified lumbar central canal stenosis into four grades: grade 0 with no stenosis, grade 1 mild stenosis with the separation of cauda equine roots, grade 2 moderate stenosis with some aggregation of cauda equine roots, and grade 3 severe stenosis with entire cauda equine roots as a bundle.[11] We performed open laminectomy under general anesthesia after locating the level clinically and based on MRI findings. Twenty-nine (58%) had one-level stenosis, 17 (34%) had two-level stenosis, two (4%) had three-level stenosis, and two (4%) patients had two-level stenosis with grade 1 spondylolisthesis. Postoperatively, patients were assessed at 6 weeks, 6 months, and 12 months subjectively with ODI score, SPWT distance, and VAS. All the data, preoperative and postoperative ODI scores, SPWT distance, and VAS at 6 weeks, 6 months, and 12 months, were compiled and analyzed using dependent t test and Wilcoxon matched paired test using SSPS software. MRI grading was also compiled, and the correlation between MRI and ODI, SPWT, VAS for the leg and back pain was analyzed using Spearman's ranked correlation method. There was no conflict of interest in this study, and patient confidentiality was maintained.

Results

The mean age was 56.5 years with 29 (58%) males and 21 (42%) females. Twenty-one (42%) patients were in the age group of 50–60 and 13 (26%) in 60–70 years' group. Twenty-nine (58%) had one-level stenosis, 17 (34%) had two-level stenosis, two (4%) had three-level stenosis, and two (4%) patients had two-level stenosis with grade 1 spondylolisthesis. Based on the MRI grading, four (8%) had grade 1, 24 (48%) had grade 2, and 22 (44%) had grade 3 scoring according to Lee *et al*.[11] The mean preoperative and postoperative ODI scores at 12 months were 57.32 and 7.48, respectively, which was statistically significant. The mean preoperative and postoperative SPWT distance at 12 months was 124.92 and 1482.0 meters, respectively, which was also statistically significant [Table 1]. The percentage effect of 86.95 noted from preop to 1-year follow-up. Preop

Table 1: Comparison of different follow-up periods with respect to SPWT (in meters) by dependent t test

Time	Mean	SD	Mean difference	SD difference	% of effect	Paired t	*P* value
Preop	124.92	131.09	−528.78	303.83	−423.29	−12.30	<0.001
6 weeks	653.70	333.55					
Preop	124.92	131.09	−1169.36	296.52	−936.09	−27.88	<0.001
6 months	1294.28	309.87					
Preop	124.92	131.09	−1357.08	175.02	−1086.36	−54.82	<0.001
1 year	1482.00	127.28					
6 weeks	653.70	333.55	−828.30	326.04	−126.71	−17.96	<0.001
1 year	1482.00	127.28					
6 months	129.28	309.87	−187.72	284.96	−14.50	−4.65	<0.001
1 year	1482.00	127.28					

Significant improvement of SPWT was noted postoperatively with patients having a better walk in meters with *P* value significant at <0.001

Table 2: Comparison of different follow-up periods with respect to self-ODI (in %) by dependent t test

Time	Mean	SD	Mean difference	SD difference	% of effect	Paired t	*P* value
Preop	57.32	11.99	28.70	12.10	50.07	16.77	<0.001
6 weeks	28.62	10.03					
Preop	57.32	11.99	39.10	13.34	68.21	20.73	<0.001
6 months	18.22	8.55					
Preop	57.32	11.99	49.84	13.15	86.95	26.80	<0.001
1 year	7.48	6.07					
6 weeks	28.62	10.03	21.14	8.55	73.86	17.47	<0.001
1 year	7.48	6.07					
6 months	18.22	8.55	10.74	7.09	58.95	10.70	<0.001
1 year	7.48	6.07					

Improvement in ODI score noted with mean preop ODI score of 67% and at 1-year follow-up improvement seen with mean ODI score of only 7.48%. Percentage effect of 86.95 noted from preop to 1-year follow-up. Preop to 6-week ODI score percentage effect was only 50.07% at 6-week follow-up

Table 3: Multivariate logistic regression analysis of ODDS ratio for predicting surgical decision.

Variables	Odds ratio	(95% Confidence interval)	*P* value
VAS			
Leg pain	1.23	(0.82–1.44)	0.331
Back pain	1.11	(0.94–1.32)	0.242
ODI score	**0.72**	**(0.62–0.84)**	**0.005**
SPWT	0.9	(0.78–1.22)	0.110
MRI grade			
1	1.2		0.121
2	**1.6**	**(1.24–1.86)**	**0.003**
3	**2.2**	**(1.97–2.57)**	**0.001**

to 6-week ODI score percentage effect was only 50.07% at 6-week follow-up [Table 2]. The mean preoperative and postoperative VAS at 12 months for the leg pain was 7.44 and 0.46, respectively, with statistically significant improvement. Mean preoperative and postoperative VAS at 12 months for the back pain was 5.96 and 1.10, respectively, which showed a statistical significance. MRI grading and ODI, SPWT, VAS leg and back pain correlation were not found to be statistically significant. However, MRI grading and SPWT have negative correlation; i.e., with an increased MRI grade, there is decreased SPWT, but it is not statistically significant. Grade 3 MRI was associated with lower mean SPWT (97.18) compared with grade 2 MRI (146.3 meters) Mean ODI score preoperatively was higher in grade 3 MRI compared with grade 2 MRI. No much difference was found in VAS scoring of both MRI grades. We also did a multivariate logistic regression of odds ratio as a predictor for surgery. We found ODI scores, which depict the disability of daily living, had statistically significant higher odds to surgical prediction compared with SPWT score and VAS. MRI grade 2 and 3 also had statistically significant higher odds to surgical prediction [Table 3]. Statistical methods used for analysis were dependent t test; Wilcoxon matched paired test, and Spearman's rank correlation method.

Discussion

This study was conducted at a single teaching institute and operated by a single surgeon between 2015 and 2019. In the present study, ODI score, SPWT distance, and VAS for the leg and back pain were significantly improved

postoperatively. After surgical intervention, patients showed serial improvements in ODI scores at 6 weeks, 6 months, and 1 year, and complete return to previous work in most of the cases at 6 months. Mean ODI score at the end of 1-year follow-up was 7.48%. This shows that patients suffering from lumbar canal stenosis (LCS) have improvement in day-to-day activities of living, postsurgical intervention, which reflects in an improvised quality of life. There was 50.07% improvement in ODI score in the first 6 weeks and a total of 86.95% improvement in the ODI score at the end of 1 year. Similarly, we noticed serial improvement in walking distance postoperatively attaining maximum distance at the end of 1 year. Another study done by Sigmundsson *et al.* in 2011 did not find any correlation between MRI findings with the clinical severity of stenosis. Sigmundsson *et al.* in his study stated that SPWT is not an accurate measure of the severity of spinal stenosis as it can be reduced because of other reasons, but Ogikubo *et al.* found out the correlation between walking distance and pain on the one hand and MRI findings on the other hand.[12,13] The correlation between ODI score improvement and MRI grading was not found to be statistically significant. A similar study by Jeong *et al.* showed no statistical significance between MRI grading and surgical finding in lumbar canal stenosis in a study of 99 patients.[14] Grade 3 MRI is associated with a lower mean SPWT (97.18) compared with grade 2 MRI (146.3 meters). The mean ODI score preoperatively was higher in grade 3 MRI compared with grade 2 MRI. No much difference was found in VAS scoring of both MRI grades. In the study by Geisser *et al.*, no correlation was found between the quantitative measurement of central spinal canal antero-posterior diameter and clinical symptoms.[15] Sirvanci *et al.* found no correlation between the severity of spinal stenosis and ODI. The aforementioned study, however, was retrospective, and patient symptoms were evaluated only by the ODI scale. This study also states that higher ODI scores may not always indicate physical disability as some morphological and psychological factors also play role.[16] They found higher ODI score in patients' with psychological disturbances and depression. Kuittinen *et al.* did a prospective study to correlate between the severity of lumbar canal stenosis with VAS leg pain and objective walking ability and found out that the correlation between the severity of canal stenosis and clinical findings was complex.[17] Jain *et al.* in their study divided patients into three groups based on the severity of stenosis into severe stenosis, less severe stenosis, and simple back ache without neurogenic claudication. They used qualitative MRI classification system, dural sac cross-sectional area, and sedimentation sign. They did not found any significant correlation of ODI scores and radiological parameters.[18]

SPWT was used as criteria to evaluate the severity of LCS. It was observed that patients at the end of 1 year, 96% of the patients, had excellent SPWT of >1500 meters. This is comparable with a study by Azimi *et al.*, which shows an improvement in SPWT score in surgically treated LCS patients.[19] Azimi *et al.* validated their own version of Neurogenic Claudication Outcome Score using pre-operative and post-operative SPWT and ODI scores. They also concluded that post-operatively SPWT and ODI scores improved.[20] A study by Slätis *et al.* on 94 patients showed similar results with an improvement in ODI and walking ability in surgically treated LCS patients.[21]

Patients were also clinically evaluated with VAS scoring for the back and leg pain. It was observed that five patients had chronic back pain and four patients had recurrent sciatica at the end of 1 year. However, a majority of patients had no radiating pain and minimal back pain at the end of 1 year. Aalto *et al.* studied the preoperative predictors for postoperative functional outcome and concluded that depression, cardiovascular comorbidity, disorders influencing walking ability and scoliosis have poorer subjective outcomes.[22]

The present study and also previous studies concluded that ODI score and SPWT may influence the surgical decision-making.[23,24] We did a multivariate logistic regression analysis, which showed an association of ODI scores with a higher odds of surgical decision compared with SPWT and VAS leg and back pain. This shows that patients who are disabled in daily activities of living as suggested by ODI scores are more inclined in getting surgical decompression than patients with leg pain or radiating pain indicated by VAS leg score. There are numerous objective methods to study the outcome after surgical decompression for lumbar canal stenosis. The objective methods used are real-life physical activity using ActiGraph accelerometers and the short physical performance battery according to 2008 American Physical activity guidelines. Smuck *et al.* concluded in their study that there is a significant improvement in self-reported function and objectively measured physical capacity as measured by continuous activity monitoring.[24]

This finding suggests that activities of daily living are important than leg pain or radiating claudication pain.[23] We also found out an association of grades 2 and 3 had higher odds of surgical decision compared with grade 1 MRI severity scoring.

The complications encountered in the study were surgical site infection, recurrent radiculitis, and chronic back pain. None of the cases required revision surgeries. One patient with surgical site infection was treated with redebridement in the operating theater and antibiotics according to the culture and sensitivity for 6 weeks. The patient had followed up with no signs of infection

at the end of 1 year but had chronic back pain with moderate SPWT and ODI score of 38% at the end of 1 year with no neurological deficits. Four patients had recurrent radiculitis who were managed conservatively as the mean VAS was 4.75. Five patients had chronic back pain with the mean VAS of 3.6 and were managed conservatively as the back pain was not disabling them from their daily activities and professions. Radiological evaluation (flexion and extension views) did not show any lysthesis in five patients. At the end of 1 year, all patients were assessed for postoperative instability clinically. Out of those, patients who had chronic back pain were evaluated with dynamic radiographs and none of them had lysthesis. However, long-term follow-up is required to assess instability. According to a study by Pao *et al.*, the VAS for the leg pain was improved from 7.3 ± 2.2 to 0.9 ± 0.7, and the VAS for the back pain also improved from 4.3 ± 3.0 to 1.2 ± 1.0. The ODI was improved from 54.6 ± 16.9 to 14.6 ± 12.6.[25] According to Li *et al.*, the mean ODI improved from 43.33 ± 7.32% preoperatively to 22.56 ± 8.63% at the last follow-up. In a similar manner, the VAS for back decreased from 6.06 ± 1.35 to 2.39 ± 0.78 ($P < 0.001$), whereas the VAS for leg decreased from 5.39 ± 1.24 to 1.89 ± 1.02 ($P < 0.001$).[26] Preoperative, and 3- and 6-month postoperative values for VAS, ODI, and claudication distance were as follows: VAS, 63.88 ± 8.56 versus 13.22 ± 8.24 and 6.83 ± 9.43; ODI, 59.96 ± 12.60 versus 9.08 ± 10.55 and 5.64 ± 6.84; and claudication distance, 114.55 ± 150.22 versus 1363.97 ± 321.44 and 1410.39 ± 306.71. Postoperative VAS, ODI, and claudication distance at 3 months and 6 months were significantly improved compared with preoperative values.[27] Sun *et al.* studied outcome and safety of 38 patients with lumbar canal stenosis treated with endoscopic laminectomy. They also used preoperative ODI scores and JOA scores compared with postoperative scores. They found a significant improvement in ODI scores postoperatively at the end of 1 year.[9] Verbiest *et al.* in their long term study on decompression for idiopathic lumbar stenosis concluded that sciatica and intermitent claudication were cured better than the radicular deficits and lumbago.[28]

The incidence of LCS is increasing probably because of the better quality and availability of radiological imaging equipment, and facilities, added to increasing aging population, which reflect in a higher number of LCS surgery.[29,30] However, the selection of patients for surgical treatment still remains challenging. Our results strengthen the classical conception that the diagnosis of this syndrome is constituted by the clinical history, clinical symptoms, and radiographic evidence of a demonstrable stenosis. Our study also implies the use of self-assessed subjective measures as preoperative and postoperative outcome measures. These subjective analysis methods help to know the postoperative quality of life and also time taken to resume back the profession of the patient. Katz *et al.* also emphasised the importance of history and physical examination findings before diagnosing and subjecting the patients' to surgery.[31]

MRI evaluations are thus needed to establish the level(s) and severity of stenosis. However, MRI images cannot be the only decision-making factor of surgical treatment selection for LCS patients. The degree of the severity of the disease cannot be judged based solely on MRI either. Sairyo *et al.* found that the hypertrophy of the lumbar ligamentum flavum is associated with inflammation-related genes.[32] Caputy *et al.* in their long term evaluation of decopressive surgery for degenerative lumbar stenosis concluded that prophylactic stabilization should be carried out at the levels of spondylolisthetic stenosis and the initial decompression include adjacent symptomatic stenosis levels also.[33] Atlas *et al.* concluded that upto 4 years the results of surgical decompression for lumbar canal stenosis were better than non surgical treatment. the relative benefits of surgery declined over time but remained superior to non surgical treatment.[34]

Most of the spine surgeries outcomes are evaluated by objective methods, which do not reflect on the quality of life. Hence there is a need to use subjective methods to analyze the spine surgical outcomes as most of the modern spinal surgeries are done to improvise the quality of life.

Limitations

The drawbacks of this study are short-term follow-ups, which requires long-term follow-ups. Another drawback of this study is smaller sample size. There are newer qualitative scoring systems such as Neurogenic Claudication Outcome Score and Swiss Spinal Stenosis Questionnaire, which have been suggested.

Conclusions

ODI score, SPWT distance, and VAS for the leg and back pain can be useful instruments for measuring clinical outcome after spine surgeries. We conclude surgical decompression for degenerative lumbar stenosis gives excellent clinical results in terms of patient's quality of life as suggested by improved postoperative ODI score, SPWT distance, and VAS compared with preoperative scores. There is no correlation between MRI findings and clinical findings in degenerative lumbar canal stenosis. ODI score can be used as a predictor for surgical treatment in preoperative evaluation.

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Conflicts of interest

There are no conflicts of interest.

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