Enduring improvement in Oswestry Disability Index outcomes following lumbar microscopic interlaminar decompression: An appraisal of prospectively collected patient outcomes

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Abstract

Objectives: Our present study aims to assess the short and long-term postoperative outcome of microscopic interlaminar decompression from a neurosurgical center in a developing country and also aims to further determine any predictors of functional outcome. Materials and Methods: All patients with moderate to severe symptomatic stenosis undergoing elective posterior lumbar spinal decompression were prospectively enrolled in a database. Preoperative, 2 weeks and 2 years postoperative Oswestry Disability Index (ODI) scores were determined for all patients. These scores were retrospectively compared using repeated measures analysis of variance. Further, linear regression modelling was applied to determine the effect of preoperative ODI, body mass index, age, prior physiotherapy, duration of symptoms, and single or multiple level decompression on the change in ODI at 2 weeks and 2 years follow-up respectively.

Results: A total of 60 consecutive patients (40 males, 20 females) were included for statistical analysis. The percentage of patients with a minimum clinically important difference (MCID), using an ODI threshold value of 10, was 86.7% (n = 52) at the 2 weeks postoperative follow-up. At the 2 years follow-up assessment, 3.3% (n = 2) patients who had earlier not achieved MCID did so, 78.3% (n = 47) of patients were found to have a change in ODI score of <10 or no change, while 18.3% (n = 11) reported a deterioration in their ODI scores. The preoperative ODI score was an independent predictor of change in ODI at 2 weeks and 2 years respectively (P < 0.0005). The duration of symptoms prior to surgery was found to predict the change in ODI at 2 years follow-up (P = 0.04).

Conclusion: The evidence regarding the long-term and short-term efficacy of microscopic interlaminar decompression in symptomatic lumbar stenosis is overwhelming. Preoperative ODI scores and duration of symptoms prior to surgery can predict postoperative outcomes.

Key words: Functional outcome, interlaminar decompression, lumbar spinal stenosis, microscope, minimally invasive surgery, Oswestry Disability Index, spinal decompression
INTRODUCTION

Degenerative lumbar canal stenosis is progressive narrowing of the spinal canal in the lumbar region and leads to compression of the thecal sac and nerves, eventually resulting in symptomatic neurogenic claudication.[1] Mild lumbar canal stenosis is managed conservatively in most patients with favorable functional outcomes.[2,3] However, patients with moderate to severe symptomatic stenosis often require surgical decompression of the spinal canal.[4]

Decompressive procedures for lumbar canal stenosis historically involved bilateral wide laminectomy with extensive disruption of the paravertebral muscles, ligaments and vertebral posterior arches including the spinous processes and intervertebral facet joints.[5] However, the microscopic interlaminar decompression[6] is a procedure which involves a smaller midline incision, minimal disruption of posterior muscle and ligamentous complexes, followed by interlaminar fenestration and ligamentum flavectomy to microscopically decompress the compressed nerves.

Our present study aims to assess the short-term and long-term postoperative outcomes of microscopic interlaminar decompression in patients diagnosed with symptomatic degenerative lumbar spinal stenosis, using a standardized functional outcome assessment tool.

MATERIALS AND METHODS

Study design
This study is a retrospective review of prospectively collected patient-based outcomes in patients who underwent a standard interlaminar decompression at the Aga Khan University Hospital between January 2007 and May 2009. All patients undergoing elective posterior lumbar spinal decompression for symptomatic single level or multilevel degenerative lumbar spinal stenosis were prospectively enrolled in a database with a minimum of 2 years of follow-up and complete outcome assessment. The decision for surgery was based on a comprehensive assessment based on history, clinical examination and magnetic resonance imaging (MRI) scans; all patients enrolled in the study had moderate to severe symptomatic stenosis. Patients with associated pathologies such as instability, infection, malignancy, or a previous history of surgery for lumbar stenosis or lumbar spinal fusion were excluded from the study. Also, those patients that required a discectomy in addition to interlaminar decompression were excluded from the final analysis.

Study intervention
All decompressive procedures were performed by the same surgeon (SAE). With the patient in a prone position under general anesthesia and all bony prominences well-padded, a midline skin incision was made centered at the interspinous level to be decompressed (e.g. L4/L5 interspinous level in case of L4-L5 decompression). Subcutaneous dissection was done, and the lumbosacral fascia was exposed. Once this was exposed, a Kocher clamp was placed, and a localizing cross table X-ray confirmed the interspace between the spinous processes. The relevant spinous process was palpated followed by subperiosteal dissection. The lamina (e.g. the L4 lamina in case of L4-L5 decompression) was exposed bilaterally followed by exposure of the upper edge of the lower adjacent lamina (L5 lamina in case of L4-L5 decompression). This was followed by a bilateral laminotomy (lower edge of L4 lamina) and bilateral medial facetectomy of the concerned facets under the operating microscope. Subsequently, a ligamentum flavectomy was done, the thecal sac was decompressed, and the lateral recess and foraminal stenosis was relieved by undercutting of facet joints. Decompression was done bilaterally if stenosis was observed on both sides.

Study measures
The Oswestry Disability Index (ODI) assessment scale was used for preoperative, 2 weeks postoperative and 2 years follow-up assessment. The ODI is a self-completed questionnaire by the patient that examines perceived level of disability in 10 everyday activities of daily living to assign a subjective score of the level of function. It is a standardized, and validated assessment tool with easy comprehension and hence can be used to determine a wide domain of the function, pain, and limitation in health status before and after back surgery.

Statistical analysis
Demographic data collected included age, gender, comorbidities and body mass index (BMI), prior history of physiotherapy and duration of symptoms. Statistical analysis was performed to assess the outcome of patients in terms of preoperative, 2 weeks and 2 years follow-up ODI assessment. A change in ODI score of at least 10 has been reported in literature to result in a minimum clinically important difference (MCID). This threshold value was used to determine the percentage of patients with clinical improvement at the 2 weeks and 2 years follow-up respectively. Moreover, data was analyzed with repeated measure analysis of variance to compare ODI scores at the three different intervals (preoperative vs. 2 weeks follow-up, preoperative vs. 2 years follow-up, 2 weeks vs. 2 years follow-up). Linear regression modelling was used to determine the effect of preoperative ODI, BMI, age, prior physiotherapy, duration of symptoms, and single or multiple level decompression on the change in ODI at 2 weeks and 2 years follow-up compared to the preoperative ODI assessment. A P value of 0.05 was taken to be statistically significant.

RESULTS
A total of 71 consecutive patients initially satisfied our inclusion criteria and were incorporated into a database. However, 60 of the 71 patients had an eventual follow-up of 2 years with complete outcomes assessment and were therefore included in the study for further analysis. There were 40 males (67%) and 20 females (33%), with a mean age of 55.7 ± 13.6 years and an average BMI of 28.9 ± 5.6 kg/m² [Table 1]. Comorbid
included diabetes (n = 8), hypertension (n = 17) and ischemic heart disease (n = 3). All patients had back pain and/or clear symptoms of neural claudication/radiculopathy with a corresponding radiological correlation on MRI. The average duration of symptoms before surgery was 3.7 years (range: 1-15 years). A total of 58 patients (96.7%) had a prior history of conservative management while 39 patients (65%) had undergone physiotherapy for relief of symptoms. The mean length of stay in the hospital after a standard microscopic interlaminar decompression was 3.2 ± 1.4 days. All patients were discharged with standard postoperative precautions to avoid heavy lifting and nonnarcotic analgesics (Nuberol Forte, Brufen) to be tapered gradually over the ensuing 2 weeks; none of the patients were recommended any postoperative physical therapy other than gradual return to routine physical activity as tolerated.

A repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean ODI score differed significantly between time points (F [1.578, 118] = 244.392, P < 0.0005). Post-hoc tests using the Bonferroni correction revealed that significant change in mean ODI scores occurred between preoperative and 2 weeks postoperative assessments (29.5 ± 7.1 vs. 12.9 ± 4.6, respectively) with a P < 0.0005, and between preoperative and 2 years follow-up assessments (29.5 ± 7.1 vs. 11.50 ± 6.2 respectively) with P < 0.0005 [Figures 1-3]. However, although the 2 years follow-up ODI score was reduced to a mean of 11.5 ± 6.2, it was not found to be statistically significantly different to the 2 weeks postoperative ODI score (P = 0.204).

Linear regression analysis showed that the preoperative ODI score was an independent predictor of change in ODI score at 2 weeks and 2 years respectively (P < 0.0005); patients with worse preoperative ODI scores achieved greater ODI postoperative improvement with a regression coefficient of 0.81. Preoperative BMI, age, comorbids, duration of symptoms, physiotherapy and extent of decompression (single vs. multiple) were not significant predictors of change in ODI at either the 2 weeks or 2 years follow-up. Interestingly, the duration of symptoms prior to surgery was found to predict the change in ODI at 2 years follow-up after having adjusted for all other variables (P = 0.04); patients with a greater duration of symptoms prior to surgery had a smaller change in ODI with a regression coefficient of −0.20 [Figure 4 and Table 2].

The percentage of patients with MCID, using an ODI threshold value of 10, was 86.7% (n = 52) at the 2 weeks postoperative follow-up and 83.3% (n = 50) at the 2 years follow-up compared to the preoperative assessment. At the 2 years follow-up, 3.3% (n = 2) of patients who had earlier not reached MCID did so, 78.3% (n = 47) of patients were assessed to have a change on ODI score of <10 or no change compared to the 2 weeks postoperative assessment while 18.3% (n = 11) reported a deterioration in their ODI scores.

### Table 1: Patients’ demographics (mean ± SD where applicable)

| Demographic                      | Number |
|----------------------------------|--------|
| Included patients                | 60     |
| Age (years)                      | 55.7±13.6 |
| Duration of symptoms (years)     | 3.7±4.4 |
| BMI (kg/m²)                      | 28±5.6 |
| Patients with prior physiotherapy| 39     |
| Single level decompression       | 32     |
| Multiple levels decompression    | 28     |

SD: Standard deviation, BMI: Body mass index

### Table 2: Association between predictors and change in ODI scores at 2 weeks and 2 years

| Predictors                          | Standardized coefficient (β) | P       |       |       |
|-------------------------------------|-------------------------------|---------|-------|-------|
|                                    | 2 weeks                       | 2 years | 2 weeks | 2 years |
| Gender                             | −0.12                         | −0.05   | 0.16   | 0.61   |
| BMI                                | 0.09                          | −0.04   | 0.60   | 0.82   |
| Age                                | −0.15                         | 0.06    | 0.07   | 0.58   |
| Duration of symptoms (years)       | −0.11                         | −0.20   | 0.18   | 0.04*  |
| Physiotherapy                      | 0.03                          | −0.07   | 0.75   | 0.48   |
| ODI preoperative                   | 0.81                          | 0.85    | 0.00*  | 0.00*  |
| Levels of decompression            | −0.04                         | −0.04   | 0.60   | 0.65   |

*Statistically significant. BMI: Body mass index, ODI: Oswestry disability index

### DISCUSSION

Degenerative lumbar canal stenosis has become a common disease entity with our increasingly aging population; spinal stenosis is the most common reason for lumbar spine surgery in adults over the age of 65 years.[7] The goal of surgical treatment of lumbar stenosis is sufficient decompression of the spinal canal with minimal operation-induced trauma. The Spine Patient Outcomes Research Trial, the largest study of its kind, showed that patients with symptomatic spinal stenosis compared to those treated nonoperatively maintained greater improvement in pain and function through 4 years. Traditionally, standard decompressive procedures[8-10] involve total laminectomies and extensive removal of the accompanying spinous processes and posterior arches. However, microscopic interlaminar decompression involves focused decompression between adjacent laminae, with the spinous processes, and their attaching muscles kept intact.[11] The facet joints are also spared, midline structures including the ligaments and fascia are preserved, and the supporting lumbar musculature is not disrupted. Overall, this reduces surgical trauma, protects the dura from epidural scarring[12] and keeps the integrity of the spine intact.

Microsurgical interlaminar decompression has been repeatedly shown to produce comparable clinical results to standard laminectomies, with the added advantage of limited resection.
Caspar et al. reported a favorable outcome rate of 71% in a series of 56 consecutive patients treated with interlaminar decompression. Kalbarczyk et al. published comparable results for both interlaminar and standard laminectomy groups. Spetzger et al. further demonstrated that less invasive and more limited interlaminar decompression resulted in an increase in interface diameter measured on postoperative neuroradiological images as well as in gross pathological specimens. The ODI scores for our patients improved significantly after surgery, with 86.7% and 83.3% of all patients achieving MCID at the 2 weeks and 2 years follow-up assessment respectively, compared to the preoperative ODI assessment. However, the rate of decrease in the ODI score decreased by the 2 years follow-up assessment, with only 3.3% (n = 2) of patients achieving the threshold for MCID while 78.3% of patients did not have a significant decrease in their ODI scores at the 2 years follow-up compared to the 2 weeks assessment. Further, 18.3% of patients at the 2 years assessment were found to have worsened ODI scores compared to the 2 weeks postoperative assessment. The radiology and preoperative ODI scores of the patients that reported a deterioration in their scores were reviewed to explain the relative difference in their outcome compared to the rest of the patients, but no confounding or association could be determined (statistical analysis and results not shown). All of these patients were also called up for further assessment. Six of the 11 patients reported that their routine activities did not cause pain in spite of the increased ODI at, while 5 patients complained that the immediate improvement after surgery had worn off and that they would consider a repeat decompressive surgery.

Our results show that functional improvement between the 2 weeks and 2 years follow-up in terms of ODI scores was not significant. However, the ODI scores recorded at the 2 years follow-up were still significantly less than the preoperative ODI scores (P < 0.0005). Such time-related deterioration in surgical results in patients undergoing spinal canal decompression has been previously reported and long-term outcome reviews report slowly decreasing levels of patient satisfaction with time, possibly secondary
to bone regrowth in some cases.\textsuperscript{[16,17]} We employed regression analysis to determine any possible determinants for the short-term and long-term functional outcome of our patients. However, after having adjusted for all other confounding factors, we only found preoperative ODI scores to be significant predictors of change in ODI both for short-term and long-term outcomes. Other studies have also shown that postsurgical outcomes correlate with the severity of preoperative stenosis.\textsuperscript{[18]} Moreover, analysis of the 2 years ODI scores in our study revealed a negative association between duration of symptoms prior to surgery and change in ODI between the 2 weeks and 2 years ODI score, depicting that a longer duration of symptoms of stenosis is likely to result in poor long-term outcome. A similar finding has been reported in a few other studies.\textsuperscript{[2]} Ng et al. reported that symptom duration of more than 33 months in patients undergoing lumbar decompression surgery had a less favorable functional outcome at the 1-year and 2 years follow-up assessments.\textsuperscript{[19]} Similarly, studies in patient with sciatica indicated unfavorable outcomes if the pain had lasted longer than 6-8 months prior to surgery.\textsuperscript{[20]} Nevertheless, we stress cautious interpretation of our results until future studies with larger sample populations confirm a definitive association between the duration of symptoms and long-term outcomes. Perhaps, such an association could be used to define the optimum time for surgical intervention in patients with symptomatic lumbar canal stenosis.

**CONCLUSION**

A valid criticism of this study is the small sample size and lack of comparison with other standard decompression techniques. Nevertheless, the evidence regarding the long-term and short-term efficacy of interlaminar decompression on the basis of improvement in ODI scores is overwhelming. We conclude that microsurgical interlaminar decompression is an effective intervention in improving functional outcome in patients with degenerative lumbar canal stenosis. Further, none of the patient characteristics and the level and extent of decompression predict short-term and long-term outcome in these patients, with the exception of preoperative ODI scores and duration of symptoms prior to surgery.

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**Conflicts of interest**
There are no conflicts of interest.

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