

Surgical Management of Lumbar Spinal Stenosis; Analysis of Pre-Operative Risk Factors Affecting Outcome

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ABSTRACT

Objective: To evaluate pre-operative risk factors have impact upon post-operative outcome in terms of pain and functional improvement after surgical decompression of lumbar spinal stenosis.

Methods: Retrospective analysis of prospectively data was collected for LSS patients from backache care service until 6 months post-operatively. Neurological and medical factors were identified and were assessed in terms of post-operative improvement in VAS pain scores as well as ODI functional improvement.

Results: Forty five patients were included with 62.2%(n=28) males & 37.8%(n=17) females. Mean age was 61.98 years \pm 7.06 SD (range: 47-75 years). Mean duration of symptoms was 27.11 years \pm 8.88 SD, 80% of patients achieved effective pain relief and favourable functional improvement. The pre-operative risk factors included tobacco use (24.4%), mostly in the form of 'Naswar'. Comorbid conditions were present in 46.7% patients and included diabetes (15.6%), hypertension (11.1%) and osteoarthritis (8.9%), 13.3% patients had history of previous spine surgery, mostly for prolapsed lumbar intervertebral disc. Surgery was significantly associated with improvement between pre- & post-operative pain scores and ODI scores ($p < 0.001$). Tobacco use was significantly associated with poor pain functional improvement ($p = 0.001$). No association was found for gender ($p = 0.64$), age ($p = 0.094$), comorbid ($p = 0.88$), duration of symptoms ($p = 0.67$) or previous surgery ($p = 0.82$) for predicting post-operative prognosis.

Conclusion: Surgical intervention is a good choice in relieving pain and disability due to lumbar spinal stenosis. Tobacco use is a risk factor strongly associated with poor outcomes.

Keywords: Lumbar spinal stenosis, laminectomy, surgical outcome, pre-operative risk factors.

Abbreviations: LSS: lumbar spinal stenosis, EPR: Effective pain relief, ODI: Oswestry disability index, VAS: Visual analogue scale

INTRODUCTION

Spinal stenosis was initially described by Portal in 1802 while the clinico-pathological description & decompression of the spinal canal are attributed to Verbiest in 1950s.¹ There are two main types of spinal stenosis by aetiology; congenital which is rare and the acquired degenerative type, which is highly prevalent in patients above the age of 50 years. At the age of 65 years, spinal canal narrowing is detectable in 5.7% to 10.1% patients while it is present in 20% individuals at 70 years of age.^{2,3} It is estimated that among patients who consult a physician for backache, 3% to 14% have spinal stenosis.¹

Lumbar spinal stenosis (LSS) has an insidious course and very limited non-specific clinical features. The most common presentation is neurogenic claudication with variable degrees of backache, weakness and radicular pain in the lower limbs. Over the course of time, experts have advised various kinds of conservative and surgical treatments.^{4,5} However, once the conservative therapies fail, the conventional treatment of choice is a wide laminectomy.⁶ This procedure has been modified to be less traumatic for the soft tissues as well as the bony structures of the spine. Fenestration, laminotomy, laminoplasty⁷, endoscopic and minimally invasive procedures⁸ are a few to name which have been introduced over the last 10-20 years.⁴ However, a consensus regarding the best surgical technique has still not reached.⁹

Evidence base for operative treatment of LSS is increasing over time and several randomised trials^{4,10} have shown the favourability of operative treatment

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against non-operative treatment. Outcome measures commonly include the VAS pain score, Oswestry Disability Index (ODI) or Japanese Orthopaedic Association (JOA) scores. The current emphasis is upon identification of pre-operative predictors of favourable or unfavourable outcome. In the Swespine¹¹ registry data for 2012, about 64 % patients were satisfied following decompression surgery while only 13% were dissatisfied. In order to lower the dissatisfaction rate and the appearance of complications effectively, further research is required to identify the predictors of surgical outcome.

We aim to conduct this study in order to quantify the effect of surgical intervention as well as to identify pre-operative factors, which may predict favourable or unfavourable outcome in terms of VAS pain score and ODI score. Using this data, we can enhance our understanding of the surgical outcome in relation to the pre-operative predictors.

METHODS

The Study is a retrospective review of prospectively collected data of patients from January 2014 to June 2015 (18 months). The study was conducted after the approval of the Institutional Research & Ethics Committee.

Data Collection

The patients after admission completed the pre-operative VAS pain scores and ODI (Urdu version). A family member or ward staff members assisted those patients who had difficulty reading the questionnaires.

Data was collected about patient's demographics, diagnosis and pre-operative risk factors such as smoking, co-morbidities, previous surgery, pre-operative VAS and ODI scores. Data was also collected about intra-operative findings, procedure for decompression, intra-operative complications and post-operative complications and VAS plus ODI scores. The follow-up data was available for about 6 months.

The inclusion criteria were; i) confirmed diagnosis of lumbar spinal stenosis in symptomatic patients iii) patients who had previous history of stenosis surgery but who require re-operation, ii) ≤ 2 levels of stenotic involvement, iii) patients operated during the above mentioned period.

Exclusion criteria were; i) patients of prolapsed inter-vertebral disc, ii) the requirement of instrumental fusion due to significant spondylolisthesis or fractures,

iii) spinal diagnoses such as tumour, cysts, and infection.

Outcome Measures

Visual Analogue Scale (VAS) was used for recording the overall back or lower limbs pain. Moreover, the Oswestry Disability Index (ODI) 2nd edition [12] was used which has been translated to Urdu language by Pasha IF et al [13]. It is a widely accepted outcome measure for the functional aspect of LSS patients and it very effectively quantify disability due to spinal disorders. This questionnaire includes 10 sections for various aspects of the spinal disability namely pain intensity, ability to lift, ability to self-care, walking ability, sitting, sexual function, standing, social life, quality of sleep and the ability to travel. All questions are 0 to 5-point scale, which can be converted to percentage disability (score divided by 50 x 100 = percent disability). Moreover, 5 classes on the basis of percent disability have been specified. Overall 0 to 20% is minimal disability, 21 to 40% is moderate disability, 41 to 60% is severe, 61 to 80% is crippling disability and 81 to 100% score denotes profound disability which limits a patient in all aspects of daily life and they are usually bed bound.

We postulated that an improvement below 20% (minimal disability) is a favourable outcome with at least 50% or less reduction in VAS pain score (effective pain relief, EPR). Those patient who did not achieve an EPR of $\leq 50\%$ on VAS pain score and a fall in ODI below 20% (Oswestry score: 10) following surgery up to 6 months, were classified as unfavourable outcome.

Surgical Procedure

All patients underwent wide laminectomy for decompression of the thecal sac. Under general anaesthesia and perioperative antibiotics administration, patient was positioned prone. Posterior midline incision was used which was followed by paraspinal tissue dissection using the monopolar diathermy. Care was taken to do the dissection in sub-periosteal plane along the spinous processes. The laminae were exposed up to the plane of zygapophyseal joints. Haemostasis was secured and tissue retractors were applied. Level was confirmed using intraoperative C-arm fluoroscopy. The bony decompression was completed using rongeurs. Extreme caution was taken to avoid injury to the dural sac by using cottonoids and blunt dissection techniques. Foraminal stenosis, if present was relieved

using magnification under 3x loupes. Intraoperative characteristics such as yellow ligament hypertrophy or ossification, simultaneous prolapsed disc, foraminal stenosis and spondylolisthesis were recorded. After decompression, the wound was washed with normal saline. Haemostasis was confirmed and the wound was closed in layers.

Post-operatively the patients were shifted to ward and kept on broad spectrum antibiotics for 72 hours. Dual IV analgesia was provided for pain relief. Patients were mobilised the next morning.

Data Analysis

Statistical analyses were performed using the IBM SPSS (version 22.0). A p value ≤ 0.05 was defined as statistical significance level. For assessment of normality of the data, Q-Q plots were utilised. The Chi-square test was used for categorical variables. Paired samples t-test was used for assessment of pre-operative pain and disability scores. Binary logistic regression analysis was performed for assessing the significance of the clinical risk factors regarding final outcome (pain and disability scores at 6 months).

RESULTS

Patient Demographics

45 patients were included with 62.2% (n=28) males & 37.8% (n=17) females. Mean age was 61.98 years \pm 7.06 SD (range: 47-75 years). Mean duration of symptoms was 27.11 years \pm 8.88 SD. **Table 1**

Patients commonly presented with backache (66.7%), neurogenic claudication (75.6%) and radiculopathy (28.9%). Clinical examination findings included dermatomal sensory loss (26.7%), muscle weakness (24.4%), decreased lower limbs reflexes (80%) while increased lower limbs reflexes (20%).

Pre-operative Risk Factors:

The pre-operative risk factors included tobacco use (24.4%), mostly in the form of 'Naswar'. Comorbid conditions were present in 46.7% patients and included diabetes (15.6%), hypertension (11.1%) and osteoarthritis (8.9%). 13.3% patients had history of previous spine surgery mostly for prolapsed lumbar intervertebral disc. **(Table 1 & Table 2)**

Pre-operative Radiological Findings:

In 77.8% (n=35) cases the stenosis was central while in 22.2% (n=10) cases, it was lateral canal. The most common spinal level involved was L4-L5 (48.9%), which

was followed by L1-L2 (17.8%). Multiple levels were involved in 15.6% (n=7) cases. Spondylolisthesis was present in 13.3% (n=6) cases. All cases of the concomitant spondylolisthesis were of first degree, since significant spondylolisthesis was excluded from the study.

Intra-operative Findings:

Intra-operative findings included prolapsed intervertebral disc in 6.7% (n=3) of patients. Ossification of the ligaments or disc was found in 24.4% (n=11) patients, yellow ligament hypertrophy in 28.9% (n=13) while foraminal stenosis was encountered in 24.4% (n=11) cases. Intra-operative complications included accidental durotomy in 4.4% (n=2) patients. No other complications such as massive bleeding, wrong level surgery or nerve root transection were encountered. **Table 2**

Post-operative Complications:

Post-operative complications occurred in 31.1% (n=14) patients and it included 6 (13.3%) cases of wound infection, 4 (8.9%) cases of transient urinary retention and 3 (6.7%) cases of bleeding from the wound. Only 1 patient experienced a short-term CSF leak, which was resolved after conservative treatment. Two (4.4%) patients were re-operated during the follow-up period for refractory symptoms and inadequate decompression.

Pain & Disability Measurements:

The mean pre-operative VAS pain score was 6.78 ± 0.81 SD (median: 7.0). Similarly, the mean pre-operative ODI was 21.82 ± 10.23 (median: 20.0). **(Table 1)**

The mean post-operative VAS pain score at 6 months was 1.93 ± 1.67 SD (median: 1.0). The mean postoperative ODI score at 6 months was 11.20 ± 7.05 (median: 8.0) **(Figure 1)**.

Chi-square analysis showed that tobacco use was significantly associated with poor overall effective pain relief (EPR) at 6 months ($p = 0.001$) and it was also associated with poor functional improvement (high ODI scores) at 6-month follow-up ($p < 0.001$). Similarly, the presence of radiculopathy was associated with good overall EPR at 6 months ($p = 0.033$). The presence of comorbid was, however, not significantly associated with poor EPR ($p = 0.88$) or poor functional improvement ($p = 0.23$), neither was any comorbid condition associated with increased incidence of

complications ($p = 0.31$) or higher re-operation rate ($p = 0.9$).

Paired-samples t-test was applied to pre-operative VAS and ODI scores to post-operative VAS and ODI at 6 months. The results showed a significant improvement in both scores ($p < 0.001$) after surgical decompression and at 6-month follow-up (mean reduction for VAS: 4.84 ± 2.02 SD, 95% Confidence interval (95% CI): 4.24

– 5.45 ; mean reduction for ODI: 10.62 ± 11.03 , 95% CI: $7.31 - 13.94$). A binary logistic regression between the pre-operative risk factors (age, duration of symptoms, type of stenosis, previous surgery, tobacco use, comorbidities and spondylolisthesis was performed and only the absence of tobacco use found to be significantly co-related to EPR at 6 months ($p = 0.007$).

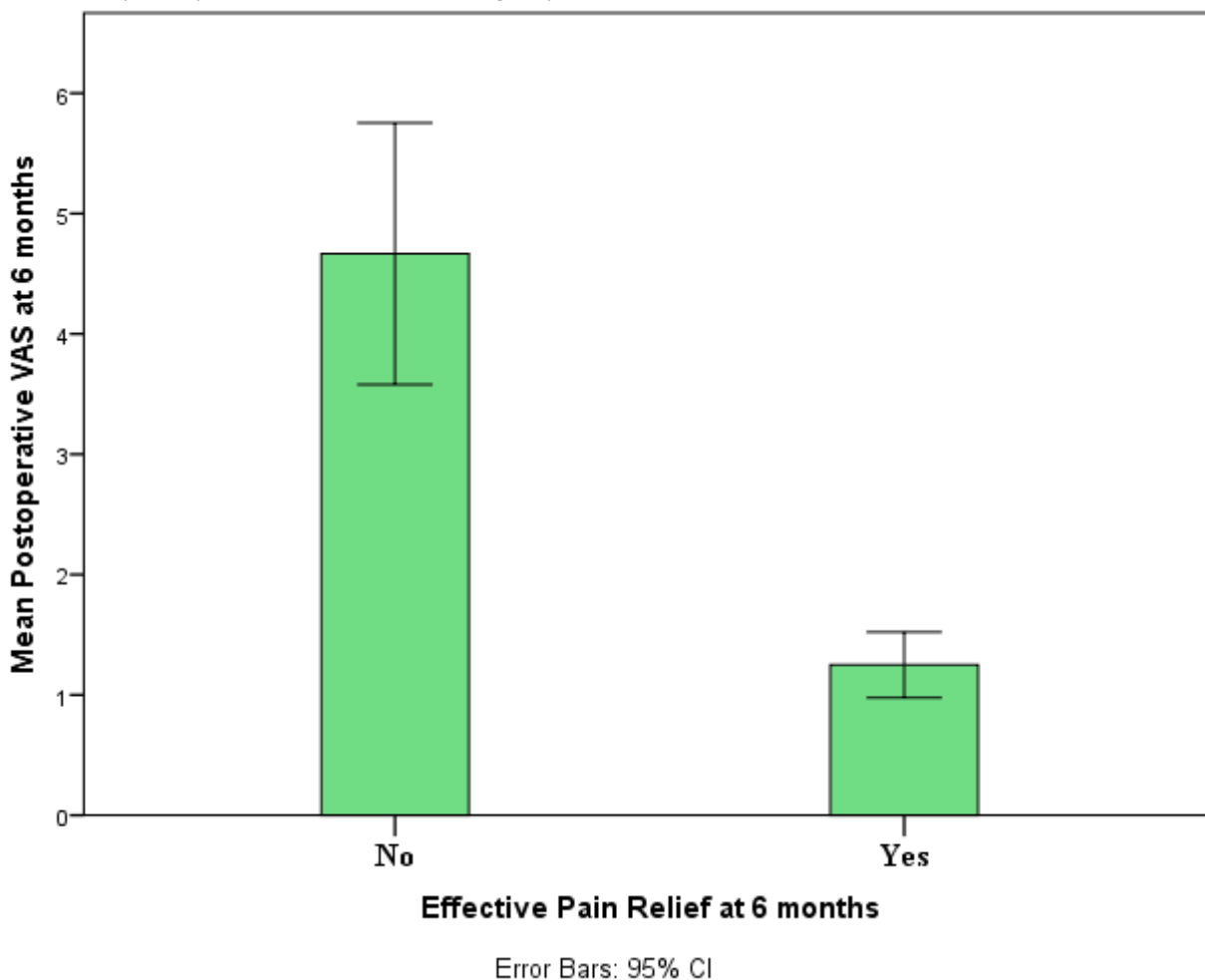
Table 1: Descriptive predictors stratification and their significance for post-operative outcome.

Variable	Favourable EPR (n = 36)	Unfavourable EPR (n = 9)	P value
Age	62.17 years \pm 7.10	61.22 years \pm 7.24	0.72
Symptoms duration	27.36 months \pm 9.67	26.11 months \pm 4.75	0.71
Preop VAS	6.92 \pm 1.31	6.22 \pm 1.30	0.11
Preop ODI	21.83 \pm 10.18	21.78 \pm 11.06	0.98
• EPR: Effective pain relief ($\geq 50\%$ reduction in pain score)			

Table 2: The pre-operative and operative predictors and their significance for post-operative outcome.

Variable	Favourable EPR (n = 36)	Unfavourable EPR (n = 9)	P value
Gender			0.64
Male	23 (36.1%)	5 (55.6%)	
Female	13 (63.9%)	4 (44.4%)	
Tobacco Use	5 (13.9%)	6 (66.7%)	0.001
Comorbids	17 (47.2%)	4 (44.4%)	0.88
Previous surgery	5 (13.9%)	1 (11.1%)	0.82
Backache	25 (69.4%)	5 (55.5%)	0.42
Claudication	25 (69.4%)	9 (100%)	0.05
Radiculopathy	13 (36.1%)	-	0.03
Sphincters disturbance	4 (11.1%)	1 (11.1%)	0.9
Sensory loss	10 (27.8%)	2 (22.2%)	0.73
Motor Weakness	9 (25.0%)	2 (22.2%)	0.86
Abnormal Reflexes	9 (25.0%)	-	0.09
Type of Stenosis			0.07
Lateral	10 (27.8%)		
Central	26 (72.2%)	9 (100%)	
Level of Stenosis			0.45
L1-L2	7 (19.4%)	1 (11.1%)	
L2-L3	3 (8.3%)	1 (11.1%)	
L3-L4	4 (11.1%)	-	
L4-L5	18 (50.0%)	4 (44.4%)	
Multiple	4 (11.1%)	3 (33.3%)	
Spondylolisthesis	5 (13.9%)	1 (11.1%)	0.83
Intraoperative findings			
Ossified ligaments	9 (25.0%)	2 (22.2%)	0.86
LF Hypertrophy	12 (33.3%)	1 (11.1%)	0.18
Foraminal stenosis	8 (22.2%)	3 (33.3%)	0.48
Prolapsed Disc	1 (2.8%)	2 (22.2%)	0.03

Figure 1: Mean post-operative VAS for outcome groups.



DISCUSSION

Lumbar spinal stenosis is one of the most common indications for surgical intervention in the upper middle aged and geriatric age groups. It has been estimated that about a third of patients remain dissatisfied after the intervention in terms of pain relief and functional improvement.¹⁴ This is why understanding of pre-operative predictors of good surgical outcome is essential and more importantly the identification of risks, which might predict a sub-optimal outcome after surgery.¹⁵ In a 2-year prospective follow up study, Aalto T et al¹⁴ concluded that good prognostic factors were age less than 75 years, regular analgesic use pre-operatively for < 12 months, no use of tobacco and good average health perception. However, in our study we could not relate gender (p = 0.64), age (0.094), comorbids (0.88), duration of symptoms (0.67) or previous surgery (p = 0.82) to good post-operative prognosis in terms of EPR

or favourable reduction in ODI. However, we do found tobacco use to be significantly associated with poor EPR or functional improvement (p < 0.001). We also noted that lumbar spinal level was significantly associated with poor ODI improvement, especially when multiple levels were involved (p = 0.035). This could partly be explained by the more spinal and soft tissue trauma during decompression in multiple level stenosis. Since our sample did not involve patients aged > 75 years, it is possible that this bias could be due to lower number of more elderly patients present to backache care services or it might simply be due to the lower overall life expectancy in our society. Another reason might be the confounding effect of severe comorbidities due to which elderly individuals may be more inclined to prefer medical treatment for their problems rather than seeking a surgical diagnosis. In another systematic review, Aalto TJ et al¹⁵ has described the presence of depression, pre-operative

walking capacity, severe cardiovascular or overall comorbidity, severity of central stenosis and presence of scoliosis as the predictors of poor surgical outcome in LSS patients. Airaksinen O et al¹⁶, in a extended long-term study found that age is not a predictors of surgical outcome for LSS, however, diabetes, hip joint arthrosis and pre-operative spine fractures were associated with poor outcome. Athviraham A et al¹⁷ in a 2-year prospective study has concluded that advanced age, gender, cardiovascular comorbidities, symptoms duration above 1-year, multiple levels involvement and reflex abnormalities were not predictive of poor pain relief or functional improvement. They have concluded that on average most patients who chose to undergo surgery for LSS are relieved of most of their problems, despite a smaller group of patients who might not achieve the desire outcome. These differences in various studies regarding identification of factors which influence outcome of LSS surgery points to the fact that no clear distinction can be made by simply taking into account a single or two pre-operative factors.¹⁸ Rather, the selection of patients for surgical intervention must be based on multi-factorial analysis which involve but is not limited to the age, severity of co morbidities, co-existing degenerative spinal conditions¹⁹, neuropathies²⁰, psychiatric problems²¹, and more importantly the availability of post-operative rehabilitation programs which might help the elderly and frail patients to cope better with their post-operative course.²²

The outcome analysis for LSS patients is complex and variable. On one hand studies suggest^{18,19} that radiological features can provide a clue about the final outcome after decompression while on the other hand several other studies^{4,23,24} have suggested that radiological features are not even predictive of pre-operative severity of symptoms rather than post-operative outcome predictability. These differences might be pointing towards differences in individual perception of pain^{25,26} or the limits of our pain and disability assessment instruments. However, most authors agree that VAS and ODI are one of the best instruments for assessing pain and functional level of an individual.²⁷ DeVine J et al²⁸ have concluded that there is very little correlation between change in pain scores and the change in health related quality of life. They have suggested that while evaluating spine patients, it is mandatory to separately evaluate their pain, disability, mental health and overall quality of life separately because these are all different aspects of an

individual's perception who is responding to an intervention.

In summary, it can be said that though surgical intervention is the treatment of choice for symptomatic patients, there is still more to be studied in order to identify and quantify the pre-operative factors, which might be predictive of surgical outcome.

Our study's major limitations are its smaller sample size, shorter follow-up period and its retrospective analysis of the compiled data. Studying larger samples with extended long-term follow-up and designing randomised trials involving the study of multiple aspects of physical and mental characteristics of individuals could improve these limitations.

CONCLUSION

Our study indicates that surgical intervention confers significant benefits to the patients affected by lumbar spinal stenosis in terms of pain relief and functional improvement. However, identification of pre-operative surgical outcome predictors requires larger studies with long-term follow-up.

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