THE EFFECT OF SYSTEMIC DISEASE ON PATIENT OUTCOME AFTER DECOMPRESSION FOR LUMBAR SPINAL STENOSIS: A 2 YEAR FOLLOW UP

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ABSTRACT

Objective: To explore the influence of systemic disease on the immediate and long-term outcome of surgery for lumbar spinal canal stenosis.

Design: A reprospective, cohort study.

Methods: This was a retrospective, observational cohort study of 139 patients operated for lumbar spinal canal stenosis in a single center between 2010 and 2019. Each patient was individually followed up for a minimum of two years. The biodata, systemic diseases MRI findings, and outcomes were determined and recorded, in addition to intraoperative, early, and late complications. At six months and two years, a questionnaire was filled through either an emailed copy or telephone interview. During analysis, two groups were formed, those with systemic disease and those without and results compared. Statistical tools such as ANOVA, chi square, and Student t-test were used to determine the significance of the differences in the groups. Multiple linear regressions were used to identify the predictive comorbidities.

Results: Patients with systemic disease were not only older but also had a higher BMI. The comorbidity had a significant impact on hospital stay, post-operative infection, change in vas and ODI. There were no differences in the rate of intraoperative or late complications ($p > 0.05$). Linear regression showed that for every diabetic, has a 1.5 higher chance of a complication than a non-diabetic ($p = 0.012$) after spinal surgery.

Conclusions: Systemic diseases have a negative impact on the outcome after decompression for spinal stenosis. Optimizing patients with comorbidity, particularly diabetes mellitus, is encouraged for the best possible outcome.

Key words: Systemic-disease, Spine-surgery, Outcome, Complications

INTRODUCTION

Lumbar spinal canal stenosis is a frequent cause of claudication associated with low back pain and leg pain. Apart claudication, which is considered pathognomonic, early signs include buttock, and lower extremity pain with or without numbness. Untreated, the condition may lead to significant disability. Reports from the developed world, indicate that lumbar spinal stenosis is a disease of the elderly and a leading cause of spinal disorders (1). In the developing world where growth retardation and stunting are rampant, the condition appear to cause disability in younger patients (2,3). The narrowness of the spinal canal is worsened by degeneration and deformities of the surrounding tissues; discs, ligamentum flavum and facet joints which become deformed and arthritic. Facet joints become deformed and arthritic, while hypertrophy of the ligamentum flavum and disc prolapse substantially reduce the spinal canal of a particular segment or segments. Consequently, the reduced canal size result in spinal cord and nerve root compression, hence the symptoms. Failure in conservative treatment calls for surgical decompression to remove the symptoms, improve walking ability and overall quality of life (4). Decompression is done either by the minimum approaches or the traditional open surgery. Open decompression is commonly done through laminectomy, hemilaminectomy or foraminotomy which may include medial facetectomy and occasionally partial discectomy (5,6). The long-term results of decompression for spinal decompression are variable, with some patients showing dramatic improvement on various patient outcomes (7). Burgstaller *et al*. (8) in a prospective multicenter study, showed surgical treatment to have more favorable clinical outcomes with a sustained effect over time, compared to nonsurgical treatment; but Adamova *et al.* (9)

reported satisfactory improvement in only 61% of the cases.

Apart from the surgical approach and other technical issues, it is possible there are host factors that influence outcome. The effect of general comorbidity on the outcome of surgical decompression has been studied (10). In one study, depression, cardiovascular comorbidity, scoliosis, and other disorders that influence the walking ability, were found to have poorer subjective outcome (11,12). While in another study smoking, long duration of leg pain, presence of malignancy, and neurological conditions were found to be associated with patient dissatisfaction after 1 year (13). However, investigations of the effect of systemic disease on the outcome of surgery for spinal stenosis has not been done. A large meta-analysis, however, found frailty as a predictor of mortality, long hospital stays, and discharge disposition in several distinct spinal surgery populations (14).

Our hypothesis is that systemic disease influences patient related outcomes, such as satisfaction, pain, and activities of daily living. The effect of diabetes mellitus, hypertension, obesity, cardiac and renal diseases on patient outcomes have been scantily studied. Hyperglycemia for example is known to impair leucocyte function and cause immunocompromise which is likely to cause superficial and deep tissue infection (15). Surgical site infection results in significant morbidity in the postoperative period and may lead to increased chance of reoperation, prolonged hospitalization, and even death (16).

The effect of uncontrolled hypertension has also not been fully elucidated except in one study where pre-operative high blood pressure values were related to higher frequency of postoperative spinal epidural haematoma (17). Obesity, on the other hand is expected to perhaps result in increased intra-operative complications due to restricted space, tissue damage and increased blood loss. In one study, non-obese patients were reported to have better back pain scores two years postoperatively and with extended hospital stay, and a tendency to require administration of more blood products than non-obese when fusion is performed (18).

Depression, cardiovascular disease, chronic kidney disease, osteoarthritis and smoking have been mentioned as predictors of outcome after spinal surgery (11,13,19).

This study investigates the effect of systemic disease on the outcome of surgery for lumbar spinal stenosis.

MATERIALS AND METHODS

This was a retrospective study of all cases operated for lumbar spinal stenosis between 2010 and 2019. Consent was obtained from the institutional review board allowing the study and use of patient files to obtain data.

Patient recruitment: Details of consecutive patients operated for lumbar spinal stenosis from 2010 to 2019 were entered into a data sheet. These details include the biodata, comorbidity and previous medical history, measurements of height, weight, and baseline blood pressure. After ten years, 268 patients had been operated but only 139 could be analyzed.

Inclusion and exclusion criteria: The study included all adults above 18 years who were operated for lumbar spinal stenosis during the study period. Those patients who completed a two year follow up and filled a patient outcome questionnaire at about two years were included in the study. Excluded from the study were all patients with incomplete records, traumatic conditions, those with spine infections, tumours, or severe osteoporosis. Also excluded were patients with major joint conditions such as hip, knee, shoulder, and ankle arthritis and those with gross deformity from neurological or physical conditions.

The routine management of the patients: Most patients presented with a mixture of symptoms including axial pain back pain, and leg pain with or without numbness and neurogenic claudication. As a matter of routine, patients with comorbidity were optimized by their primary medical physician and other specialists and given clearance for surgery. Patients underwent a period of non-operative treatment, consisting of analgesia, antiinflammatory drugs, and exercises (particularly swimming, and in some cases spinal injections). Obese patients were encouraged to lose weight.

Surgical candidates consisted of patients who failed to respond to non-operative treatment and those who presented with a significant neurological symptoms, (especially claudication) of more than 6 months duration, and the MRI imaging confirmed stenosis. Operations consisted of one of the following: a foraminotomy for discectomy, hemilaminectomy or laminectomy with fusion. Most of the fusion was posterior interlumbar fusion with an anterior cage support (Transforaminal Interbody

Fusion or TLIF). All operations were done by the same spine surgeon in one hospital.

Follow up: Most of the patients attended the 6 months review appointments and filled the post-surgery Visual Analogue Scale (VAS) assessment. After about two years, a questionnaire was filled either directly with the surgeon, or an email request and in some cases a telephone interview. The questionnaire provided final VAS and Oswestry Disability Index (ODI) assessment and a subjective question on patient satisfaction based on a simple scale of 1 to 10 (in the same line with VAS).

Data extraction: Patient notes, both inpatient and outpatient were used to extract data on intraoperative, post-operative progress, early complications, and late complications. Same records had patient age, gender, height, weight, and pre-existing diseases. The radiological studies (plain X-rays and MRIs) and laboratory investigations were reviewed to confirm diagnosis. Preoperative VAS and ODI were recorded in the periodical question-naires.

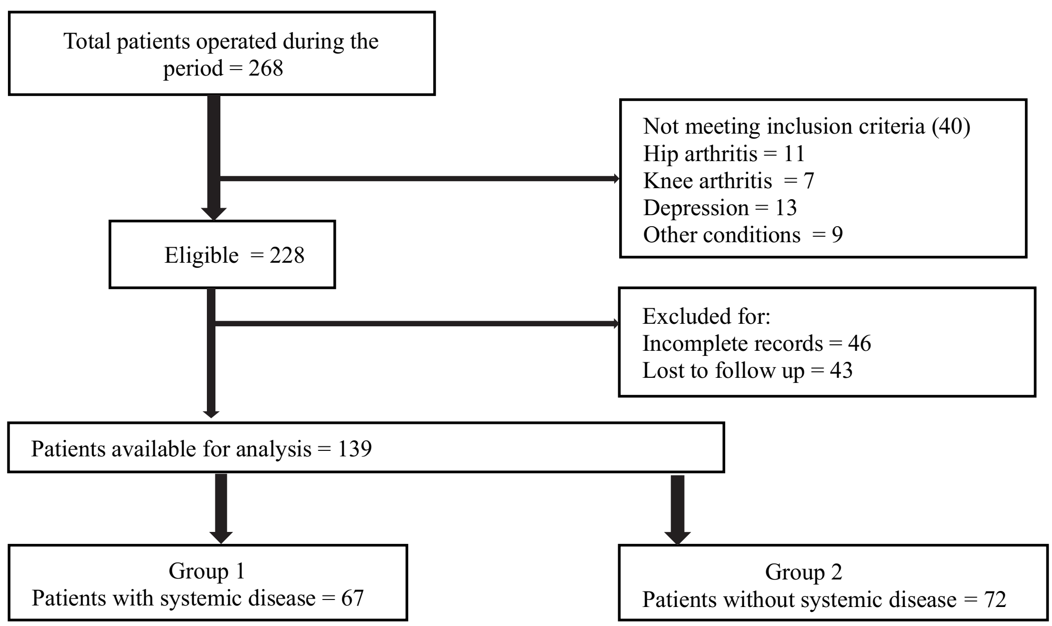
The systemic diseases which were used in this study as predictors of outcome were Diabetes Mellitus (DM), hypertension, obesity (BMI >29), retroviral disease (AIDS), Chronic Renal Disease (CKD), and cardiac disease. The outcomes were hospital stay, general patient satisfaction, change in VAS and ODI, and complications. These complications were divided into intraoperative, early complications (first six weeks), and late complications (up to two years). The participants were grouped into two, those with systemic disease (Group 1) and those without (Group 2).

Statistical analysis: Differences in frequency and means between the two groups were analyzed using the chi-square test, and student t-test, respectively. Analysis of variance (ANOVA) was performed to assess the difference in the change of survey scores between the two groups. Multiple linear regression was used to identify the most influential individual predictor on any or all the outcomes.

RESULTS

Two hundred and sixty-eight cases were operated; with 40 excluded due to other chronic conditions (such as depression, arthritis, infections, osteoporosis, etc.). Forty-six had incomplete records with vital data missing, while 43 were lost to follow up. One hundred thirty-nine participants were enrolled and analyzed for the study (Figure 1).

Figure 1
Patient sampling, selection and grouping



There was no statistical difference in gender distribution between the two groups. There was a significant difference in the mean ages, and mean BMI with Group 2 being younger (P = 0.001) and Group 1 being older and obese (P<0.001) (Table 1).

Table 1
Example - patient characteristics and prognostic factors

	Group 1 (67)	Group 2 (72)	T test or chi square
Mean age	53.2	46.1	0.001
Male	29	50	0.543
Female	38	22	
Mean BMI	29.0	24.8	<0.001
Follow up time (years)	5.1	5.8	0.0886
CLBP	11	24	0.023
Neurological symptoms	8	10	0.596
CLBP + Neurological symptoms	48	38	0.341
Motor weakness	7	0	0.009
Systemic disease	Frequency	(%)	
Hypertension	36	26	
Obesity (BMI > 29)	27	19	
Diabetes mellitus	20	14	
Retroviral disease (RVD)	5	3.6	
Cardiac disease	5	3.6	
Chronic kidney disease	3	2.2	
Other comorbidity	3	2.2	

The two groups showed different disease presentation patterns. Thirty-five patients or 25% presented with isolated low back pain (no leg pain or claudication). There were more cases of isolated back pain in Group 2 (those without systemic disease) than Group 1, a difference that was statistically significant. Interestingly, the number of cases with neurological affection was equal in both groups (P = 0.596), but for motor weakness, which was found in seven patients with systemic disease four had DM, while Group 2 had none with motor weakness (Table 1).

Due to limited sample size, the study could only accumulate a few systemic conditions that were more prevalent. The commonest were hypertension (26%), Obesity (19%), and diabetes mellitus (14%) (Table 1). It must be stated that these three conditions were in combinations and presented with so called metabolic syndrome: but rarely as isolated disease.

The greatest confounder for the outcome findings was expected to be the various methods of decompression and fusion, which would project different outcomes. The frequencies of the type of decompression were not statistically significant except that more foraminotomies were done in Group 2 than Group 1 (P = 0.001) (Table 2). The frequency of instrumentation was not statistically different in the two groups, 27 in Group 1 and 18 in Group 2 (P = 0.232).

Table 2
Type of decompression done

Decompression	Group 1	Group 2	Total	Chi square (P< 0.05)
Laminectomy	33	20	53	0.104
Hemilaminectomy	22	18	40	0.621
Foraminotomy	12	34	46	0.001
**Instrumented cases*	*27*	*18*	*45*	*0.232*
Total procedures	94	90	184	

Outcomes

There were no differences in the rate of intra-operative complications between the two groups. However, there were more early complications in Group 1 (22 cases) compared to Group 2 (6 cases), (P = 0.016), with infection being singularly outstanding, 14 cases (20%) against 4 (6%), P = 0.027. There were no differences in the late complications, between the groups P = 0.715) (Table 3). There was no mortality within the first six months of surgery (there could have been some late deaths who make a portion of patients lost to follow up).

Table 3

Intraoperative, early, and late complications

	Group 1	Group 2	Total	Chi Square (P< 0.05)
Intraoperative complications				
Dura tear	6	2	8	0.189
Nerve injury	4	1	5	0.207
No intraoperative complication	57	69	126	
Total	67	72	139	
Early complications				
Infection	14	4	18	0.027
Haematoma or dehiscence	3	1	4	0.353
DVT	2	0	2	0.143
Other	3	1	4	1.000
No early complication	45	66	111	0.016
Total	67	72	139	
Late complications				
Incomplete decompression	11	10	21	0.702
Implant failure	1	1	2	0.959
Failed back surgery	2	0	2	0.143
No late complication	53	61	114	0.715
Total	67	72	139	

Table 4 tabulates the measured outcomes. Mean hospital stay was longer in the morbid group (8.2 verses 6.9 months), P = 0.019. This group also reported less patient satisfaction (6.3 vs 8.3), P = 0.061. There was no statistical difference in preoperative, but there was improvement in VAS at six months (3.1 vs 2.9, P = 0.021). At two years, VAS in both groups showed no significant difference (4.2 vs 3.9, P = 0.098). The differences in ODI before the operation were insignificant (34.7 vs 32.2, P = 0.160) but became statistically significant after two years (20.8 vs 16.9, P = 0.010).

Table 4

Other outcomes (hospital stay, VAS, ODI, and patient satisfaction)

Outcome	Group 1	Group 2	T-test (P = 0.05)
Mean hospital stay (days)	8.2	6.9	0.019
Patient satisfaction at 6 months (mean)	6.3	8.3	0.061
Mean VAS (preoperative)	7.0	6.8	0.305
Mean VAS (six months)	3.1	2.6	0.021
Mean VAS (two years)	4.2	3.9	0.098
Mean ODI (preoperative)	34.7	32.2	0.160
Mean ODI (two years)	20.8	16.9	0.010

Multiple regression analysis

Multiple linear regression was used to identify the most influential individual factors on the outcome. Table 5 summarizes the model summary, ANOVA, and the coefficients.

Table 5
Model summary/coefficients and ANOVA

Model	R^a	R^2	Adjusted R^2	Std. Error of the Estimate	F Change	df1	Sig. F Change
Hospital stay	0.24	.06	-.011	6.238	.834	7	0.562
Early Complications	0.37	.14	.074	1.789	2.192	7	.041
Change in VAS	0.17	.04	-.041	1.372	.408	7	0.895
Change in ODI	0.31	.10	.031	8.568	1.481	7	0.183

Disease	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5.185	3.319		1.562	0.122
Diabetes Mellitus	1.446	0.565	0.307	2.559	**0.012**
Hypertension	-0.771	0.436	-0.198	-1.769	0.08
Obesity	0.615	0.445	0.143	1.382	0.170
AIDS	-0.117	0.836	-0.013	-0.14	0.889
Kidney disease	-0.459	1.086	-0.041	-0.423	0.673
Heart disease	-0.32	0.922	-0.037	-0.347	0.729

The multiple correlation coefficient R which is a measure of the quality of the prediction of the dependent variables showed low levels of predictions of various outcomes on the predictors tested. The R^2 which was the coefficient of determination (the proportion of variance in the dependent variable that can be explained by the independent variables) were also poor. However, the F-ratio in the ANOVA table which tests whether the overall regression model is a good fit for the data, only showed that early complications could be predicted in a statistically significant level by the independent variables put together, $F(7) = 2.192$, $p = 0.041$.

The equation to predict possible outcomes from tested predictors (diabetes mellitus, obesity, hypertension, RVD, kidney disease, and heart disease) was only statistically significant for diabetes mellitus. For diabetes mellitus the unstandardized coefficient, was equal to 1.446, which means that for each diabetic, there is a 1.5 higher chance of a complication ($P = 0.012$).

DISCUSSION

Comorbidity has been shown to be a risk factor for spinal surgery, that may lead to complications and increase cost of care (20). Comorbidity is a general word that encompasses any pre-existing condition the patient has, some localized like joint arthritis, peptic ulcer disease, cataracts and so on. Comorbidity also encompasses systemic disease. The localized conditions have a bearing on the general welfare of the host, medications which may alter the systemic milieu, but more importantly some have an impact on the rehabilitation programme, hence, completeness of recovery and the recovery period. Systemic disease on the other hand affects every single organ and tissue of the body and is, therefore, more likely to affect the outcome of treatment, including, surgical outcomes in the short and long term. Individual conditions have different risk profile; for example, diabetes mellitus and immuno-suppression (from disease or drug-induced) have been shown to predispose to sepsis, (21,22) and increased cause increased mortality in the affected patients (23). These same conditions, result in hypercoagulable states which may lead to higher incidences of veinous thrombosis and embolism (24). In this study, we found increased incidence of early complications, especially infections in those patients with diabetes (Tables 3 and 5).

Retroviral disease, particularly HIV, is a major cause of immuno-suppression, it is therefore, commonly assumed and rightly so that HIV-positive persons have a higher risk of sepsis and other complications. Therefore, many surgeons avoid undertaking major surgery on these patients, particularly when the CD4 count is low. Young *et al* (25) in a small sample of asymptomatic HIV-seropositive persons undergoing elective spinal surgery (mean CD4 count of 279 cells/mm^3) found 2 out of 11 cases developed sepsis. In a larger sample of more than 40,000 HIV positive patients undergoing elective lumbar spinal fusion Chester *et al*. (26), found the main comorbidity to be chronic obstructive pulmonary disease with lower rates of obesity, hypertension, and diabetes. The complication profile included in-hospital mortality, wound complications, respiratory and neurologic complications, and higher costs compared with non-HIV patients. In this study we only had five cases of RVD due to HIV, a number that was inadequate for analysis.

Obesity is commonly associated with type 2 diabetes mellitus and hypertension as part of the metabolic syndrome and therefore, potentially carries with it similar risk profile as diabetes mellitus (27). For this reason obesity was included in this study as a systemic disease in this study. The group with systemic disease was older and had a higher mean BMI, a difference that was statistically significant. The possible explanation for this is perhaps a more sedentary lifestyle in these patients. The study had anticipated an increased rate of intra-operative complications, particularly dural tears. The rate of incidental dural tears was 6%, which was not directly associated with obesity. However, Burks et al. (28) analyzing a large administrative database of spine surgery found that incidental durotomy ranged from 0.5% to 2.6% and found that obesity was associated with increased rates of incidental durotomy in their series. The study too had expected increased infection rate in the obese cohort; predisposed by a deep layer of poorly perfused adipose layer, more aggressive retraction during surgery and more intraoperative blood loss (due to wider exposure and the stripping of the posterior spinal muscles).

The rate of post-operative sepsis was high (13%), with those with systemic disease having a rate of 21% compared to the control group (6%), the difference was statistically significant (P = 0.027). However, we found no significant differences in the rate of post-operative sepsis attributable to obesity. Larger studies, however, clearly show obesity to be a risk factor for sepsis. Seicean *et al*. (29) in a multicentre study consisting of 49,314 cases categorized according to their BMI, found BMI to be an independent risk factor for adverse outcomes in morbidly obese patients (BMI >40kg/M^2). Rafael *et al* (30) analysed 10,387 patients with high BMI and found higher complication rates after lumbar surgery than patients who are non-obese.

Hypertension is a modifiable risk factor for cardiovascular related outcomes, including post spinal surgery; meaning that uncontrolled hypertension could be associated with post operative cardiac events and strokes. Meng *et al*. (31) in a meta-analysis for risk factors for surgical site infections following spinal surgery, found that hypertension among other conditions (such as smoking, diabetes, obesity, urinary tract infection, blood transfusion, cerebrospinal fluid leak, and previous spine surgery) are risk factors. In regard to hypertension cases in this study, there were no significant differences in the rate of intraoperative, early, or late complications between the two groups for the outcomes tested. The study found no immediate perioperative cases of cardiac events or strokes. However, some of the cases, untraceable in follow up could easily have succumbed to some of these conditions.

Frailty from whatever cause, cardiac and renal disease affect recovery from surgery apart from being an anaesthetic risk. Yagi *et al*. (32) in a study of 240 patients, grouped according to their level of frailty showed that regardless of the optimization before surgery for adult spinal deformity, there is increased risk of complications with inferior clinical outcomes in frail patients.

Schoenfeld *et al*. (33) in a study of 3,475 patients undergoing spine surgery found that age, female gender, operation time, and medical comorbidities influenced the risk of postoperative complications and mortality. The medical comorbidities studied included chronic kidney and heart diseases, among others. In this study chronic kidney disease, and chronic heart disease cases were very few. These numbers may have been affected by the stringent exclusion criterion for surgery which avoided frail and sick people. Some of them may be those who were lost to follow up.

The mean hospital stay was significantly longer (P = 0.019). The reason for increased hospital stay was probably the preoperative optimization and slower postoperative rehabilitation and control of the non-surgical conditions with a cautious attitude to avoid, diagnose and treat complications early, particularly sepsis.

Reported patient satisfaction on a simple scale as Visual Analogue Scale and the mean VAS were significantly better after 6 months in those without systemic disease (P = 0.061, P = 0.021, respectively). After two years, there was no significant difference in the mean VAS score between the groups (Table 4). In our experience a large proportion of the population suffer developmental lumbar spinal canal stenosis (2,3) and benefit greatly from decompression of a symptomatic stenosis. That may explain the early improvement on patient reported outcomes, particularly pain and neurological recovery. The differences between the two groups are related to the poor general health in the diseased group from the inflammatory state, reduced level of activity and perhaps, the effects of medications.

The mean ODI was moderately high in both groups preoperatively, with no significant differences (P = 0.160). However, after two years, although ODI had improved in both groups, the reported state of well-being and physical ability was less in those with systemic disease than those without (P=0.010). The chronic disease, therefore, progressively independently causes a deterioration in activities of daily living.

The result of multiple linear regression singles out diabetes mellitus as the single most important predictor of the tested outcomes in this study. Perhaps, with a larger sample size the other predictors would emerge. Nevertheless, this study clearly shows that those patients with a systemic disease before surgery have poor patient reported outcome.

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