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ORIGINAL ARTICLE

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Outcomes of decompression surgery for lumbar spinal stenosis in elderly diabetic patients

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Abstract The purpose of this study was to assess and compare the outcome of surgical decompression for spinal stenosis in diabetic and non-diabetic elderly patients. This is a retrospective chart analysis conducted in a university affiliated referral hospital. The participants were consecutive patients, age 65 and older, undergoing laminectomy for spinal stenosis during 1990–2000. We assessed patients' clinical and demographic data, procedures, perioperative complications, preoperative and postoperative pain intensity, basic activities of daily living (BADL), patients' satisfaction, the need for repeated surgery, and overall mortality. A total number of 62 elderly diabetic group (DG) patients undergoing decompression surgery for spinal stenosis were compared with a sex and age-matched non-diabetic control group (CG) at baseline, and a mean of 40.3 months thereafter. We found that the DG patients had more pain (p=0.042), and suffered more frequently from neurogenic claudication (p=0.0018), motor weakness (p= 0.021) and numbness of the affected limb (p=0.0069) than the CG patients. Nocturnal pain was reported in 24% of the DG patients. Pain relief was successfully achieved in both groups (p<0.001), but the patients' satisfaction was greater in the non-diabetic patients (p=0.0067). Revision surgery was more frequently performed in the DG than the CG (non-significant difference), and the time interval for such a second intervention was shorter (p=0.04) in the DG. A higher rate of post-operative complications was observed in the DG (p<0.0001). It is concluded that surgical treatment of elderly diabetic patients suffering from spinal stenosis improves BADL and ameliorates pain, but the results remain worse than those observed in non-diabetics. The outcome of diabetic patients depends upon the presence of other comorbidities, concurrent diabetic neuropathy, duration of diabetes and insulin treatment. Successful postoperative pain reduction remained the strongest factor associated with patients' satisfaction.

Keywords Diabetes · Elderly · Laminectomy · Spine

Introduction

Diabetes is the third leading chronic disease in disabled elderly patients [10]. Neuropathic pain is common in diabetic patients, and may be difficult to separate from lower extremity pain due to co-existing spinal stenosis [3, 8]. Differential diagnosis usually relies upon clinical clues such as dermatomal distribution in spinal stenosis, correlation with imaging (CT or MRI), pain aggravated by positioning and activity, neurological deficits relating to anatomical distribution, and electromyography studies. Moreover, pain may also arise secondarily to changes of posture and gait related to proprioception,

which ultimately lead to a typical mechanical low back pain [14].

About 60% of the patients with low back pains have some degree of lumbar spinal stenosis. In a survey comprising 3,000 Americans age 65 years and older, one-fifth reported experiencing low back pain [13]. This pain interferes with activities of daily living, sleep, quality of life, etc. and is associated with extensive utilization of health resources.

A previous study [5] comprising 25 diabetic and 25 non-diabetic patients concluded that the outcome of surgery was similarly successful in the two groups. Another study [17] showed poor results in the diabetic patients that may have been related to coexisting diabetic neuropathy. A recently published study by Airaksinen et al. [1] concluded that diabetes was associated with poor surgical outcome.

In light of these differences, we sought to re-evaluate the patterns associated with spinal surgery in elderly diabetic patients, and to judge outcome in terms of pain relief, activities of daily living, walking ability and patients' satisfaction.

Methods

Patients

This is a retrospective study, with a follow-up period, comprising 257 consecutive patients, aged 65 years and older, who underwent decompression surgery for lumbar spinal stenosis. Retrieval of cases was based on ICD-9 codes. Sixty-two of these patients had a preoperative diagnosis of diabetes mellitus type 2, and their data were compared with those of 62 other sex and age-matched non-diabetic control patients undergoing decompression surgery.

Data collection

All patients were interviewed upon admission using a structured questionnaire. A database was compiled retrospectively using both inpatients' and outpatients' medical records. Data included age, sex, body mass index (BMI), associated comorbidities (peripheral arterial disease, osteoarthritis, and depression), duration and treatment type of diabetes. Pain intensity was determined by visual analog score (VAS). Any limitation in performance of the basic activities of daily living (BADL i.e.dependency in dressing, washing, getting out of bed, urinary and fecal continence) was labeled as "yes" and complete independence as "no". The limitation in walking distance was graded as less than 50 m, less than 500 m but more than 50 m, less than 2,000 m but more than 500 m, and unlimited or more than 2,000 m.

The American Society of Anesthesiology (ASA) scale [15] and level of surgical intervention were recorded. Adverse events and later occurring complications were identified during hospitalization and up to 90 days after discharge from the hospital. Patients were asked to grade their satisfaction (very or somewhat satisfied, very or somewhat dissatisfied) with the surgery outcome. Finally, patients were examined and interviewed after a minimum follow-up of one year.

Statistical analysis

Descriptive statistics were performed by using KyPlot, version 3.0. Normality was compared between the groups by using the Mann-Whitney test. Comorbidities, clinical presentation, changes in BADL function, level of satisfaction and other non-parametric variables between the two groups were analyzed by the Chi-square test (SISA Tables Program). The Yates correction for chi-squares was performed whenever any of the cells in a 2×2 table was less than 5 and the unadjusted Chi-square was ≥3.84 (i.e. $p<0.05$). Odd ratios were calculated to study factors associated with the patients' satisfaction rate. Data were expressed as mean±SD, percentages or numbers.

Results

The clinical characteristic of the study population is shown in Table 1. The two groups were similar in terms of age and gender, but differed with regards to BMI. The mean number of medical comorbidities was significantly higher in the diabetic group (DG) patients ($p<0.001$). 27% of the DG patients were graded preoperatively as ASA class 3, compared with 10% of the non-diabetic control group

Table 1 The clinical characteristics of the study population (*BMI* body mass index)

Parameter	Diabetic group, *n* (%)	Control group, *n* (%)	*p*[a]
Age (mean±SD)	70.5±4.08	72.4±5.5	>0.05
Gender (females/males)	25/37	34/28	>0.05[b]
BMI (mean±SD, kg/m^2)	27.4±3.3	25.9±3.1	0.022
Comorbidities/patient (mean±SD)	3.0±1.26	2.1±0.95	<0.001
Duration of diabetes mellitus			
<10 years	13 (25)		
10–20 years	20 (39)		
>20 years	18 (35)		
Treatment of diabetes mellitus			
Diet	8 (16)		
Pills	28 (55)		
Insulin	12 (23)		
Pills plus insulin	3 (6)		

[a]Mann–Whitney test
[b]Chi-square test

Table 2 Clinical presentation of patients

	Diabetic group, *n* (%)	Control group, *n* (%)	*p*[a]
Pain			
Low back pain	44 (86)	46 (79)	>0.05
Lower extremity pain	47 (92)	44 (76)	0.043
Neurogenic claudication	45 (88)	36 (62)	0.0018
All three	35 (69)	28 (48)	0.032
Night pain	12 (24)	–	0.0003
No pain	4 (8)	8 (14)	>0.05
Motor weakness	24 (47)	15 (26)	0.021
Leg numbness	25 (49)	14 (24)	0.0069

[a]Chi-square test

(CG) patients ($\times^2$=5.3, p=0.02). The mean level of HbA_1C was 7.07% (range 5.3–8.6%), and the mean level of plasma glucose on the morning of surgery was 167.3 mg% (9.3 g/dl).

The clinical symptoms relating to spinal stenosis are reported in Table 2. The mean duration of preoperative symptoms relating to spinal stenosis was 58.7 and 48.6 months in the DG and CG patients, respectively (p>0.05). DG patients were significantly more symptomatic compared with CG patients. Twelve patients without pain were operated on due to motor weakness and severe leg numbness (similar number of patients in each group).

Intervertebral level L4-L5 was stenotic in 84% of the DG patients and 85% of the CG patients;L3. L4 was stenotic in 38% and 35%, andL5-S4 was stenotic in 30% and 29%, respectively. The mean number of levels of surgical decompression (laminectomy and/or discectomy) was 1.7±0.7 in the DG and 1.6±0.6 (non-significant difference) in the CG. Spinal decompression of a single level was performed in 22% and 50% ($\times^2$=9.44, p=0.002) of patients; two levels in 59% and 38% ($\times^2$=4.8, p=0.029), and three or more levels in 19% and 12% (p>0.05) of patients, respectively. Indeed, DG patients were operated on at a more severe stenotic stage and presented a more prominent combination of degenerative, vascular and mechanical factors (BMI 27.45±3.35 vs. 25.98±3.19; p=0.022). Diabetics also had a longer duration of conservative treatment (the duration of preoperative symptoms in DG patients was 58.69 months vs. 48.55 months in CG patients (non-significant difference).

Both groups showed significant improvements in BADL. Diabetic patients improved in transfer, bathing and dressing, but walking ability and sphincter control remained unchanged. CG patients also significantly improved their walking distance abilities, but sphincter control did not improve (Table 3).

Within both treatment groups there was a significant improvement in the ability to perform daily activities (dressing, washing and getting out of bed). Similarly, when compared to baseline preoperative levels, the VAS for pain while performing daily activities was significantly improved in both treatment groups (89.31±11.83 before and 39.22± 32.3 after surgery for the DG, and 86.57±21.33 and 33.28±23.12, respectively, for the CG, p<0.001). The difference in postoperative pain perception between the groups was non-significant. Decreases of 4 or more points of VAS were observed in 63% of the DG patients and 83% of the CG patients ($\times^2$= 5.57, p= 0.018). Increased (or unchanged) pain persisted post-operatively in 14% of the DG patients and 9% of the CG patients (non-significant difference). There was no difference whatsoever between insulin-treated and non insulin-treated patients with regards to outcome parameters.

We noted a striking difference regarding the occurrence of adverse events associated with surgery. These were reported by 67% of the DG patients and 28% of the CG patients ($\times^2$=16.1, p<0.0001) (Table 4). Two or more complications were reported in six patients of the DG and five patients of the CG. No fatalities were recorded.

Table 3 Pre- and postoperative performance of basic activities of daily living

BADL function	Diabetic group, *n* (%)			Control group, *n* (%)		
	Preoperative	Postoperative	*p*[a]	Preoperative	Postoperative	*p*[a]
Getting out of bed	37 (73)	12 (24)	<0.001	31 (53)	11 (19)	0.0001
Bathing	26 (51)	14 (25)	0.0037	29 (50)	12 (21)	<0.0001
Dressing	25 (49)	10 (20)	0.0018	17 (29)	3 (5)	0.0013
Walking distance (m)						
<50	7 (14)	4 (8)	>0.05	6 (10)	3 (5)	>0.05
<500 but >50	31 (61)	27 (53)	>0.05	32 (55)	18 (31)	0.0096
<2000 but >500	8 (15)	12 (24)	>0.05	11 (19)	21 (36)	0.038
>2000	5 (10)	8 (15)	>0.05	9 (16)	16 (28)	>0.05
Incontinence						
Urinary	9 (18)	9 (18)	>0.05	4 (7)	4 (7)	>0.05
Fecal	3 (6)	2 (4)	>0.05	–	–	–

[a]Chi-square test

Table 4 Comparison of in-hospital perioperative complications (*CHF* congestive heart failure, *COPD* chronic obstructive pulmonary disease)

Complication	Diabetic group, *n* (%)	Control group, *n* (%)
Urinary retention	7(20)	5(22)
Urinary tract infection	6 (17)	3 (14)
Exacerbation of CHF or COPD	4(12)	5(22)
Atrial fibrillation	2 (6)	2 (9)
Delirium	2 (6)	2 (9)
Wound infection	3 (9)	1 (5)
Unstable angina	2 (6)	1 (5)
Hypotension	2 (6)	2 (9)
Depression, exacerbation	3(9)	1 (5)
Gastrointestinal bleeding	2(6)	0
Cerebrovascular accident	1(3)	0
Total complications	34 (67)	22 (38)

Data regarding patients' satisfaction rates of surgery are presented in Table 4. Only 53% of the DG and 78% of the CG graded the overall surgical results as very or somewhat satisfying ($\times^2$=7.4, p=0.0067). Table 5 shows the specific variables associated with the patients' satisfaction/dissatisfaction. Despite differences in satisfaction rates between DG and CG patients, only postoperative-decreased pain predicted satisfaction (odd ratio 6.12, 95% confidence interval 1.7–21.4 for the DG, and 7.85, 1.7–35.5, respectively, for the CG).

Both groups of the study population were followed up for a mean of 41 months (range 12–115 months). The mean age at follow-up for the DG was 73.7±4.9 years and 75.8± 6.1 years (non-significant difference) for the CG. The response rate at the time of interview was 82% and 94%, respectively. 20% of the DG and 7% of the CG had undergone repeated surgery during this period ($\times^2$=2.86, p=0.09). Revision surgery (laminectomy and/or discectomy) due to unrelieved pain was performed in ten diabetics and four non-diabetics. The mean time interval between interventions was 21.2±6.9 months in the DG patients and 43.0±26.9 months in the CG patients (p=0.04). The 5-year survival rate was 82% and 91% (non-significant difference), respectively. At the end of the follow-up period, 13% of the DG patients and 7% ([$\times^2$=1.34, p=0.24] non-significant difference) of the CG patients died.

Discussion

Low back pain has long been associated with functional decline and impaired quality of life. The present study describes the characteristics and investigates the outcomes of decompression laminectomy in elderly diabetic patients. The results of the study are important with regards to a few aspects:

(a) The clinical presentation of diabetic patients was significantly more prominent. Indeed, the mean number of associated comorbidities was higher, which may explain at least some of this difference. We have considered peripheral artery disease, osteoarthritis and depression, since these conditions are frequently associated with and complicate the clinical picture. This is particularly true in the elderly, where depression is most disabling when it coexists with physical illness [2]. Such patients usually com-

Table 5 Factors associated with patients' satisfaction rate

	Diabetic group, *n* (%)			Control group, *n* (%)		
	Very/somewhat satisfied	Very/somewhat dissatisfied	p[a]	Very/somewhat satisfied	Very/somewhat dissatisfied	p[a]
ASA class						
2	26 (81)	9 (47)	0.012	29 (73)	12 (67)	>0.05
3	5 (16)	9 (47)	0.033	3 (8)	3 (17)	>0.05
Comorbidity status						
Peripheral artery disease	4 (12.5)	7 (37)	0.04	0	3 (17)	0.044
Osteoarthritis	6 (19)	9 (47)	0.02	4 (10)	6 (33)	>0.05
Depression	0	7 (37)	0.0002	0	2 (11)	>0.05
Clinical presentation						
Night pain	3 (9)	9 (50)	0.0059	–	–	–
Motor weakness	8 (25)	16 (84)	0.0001	6 (15)	9 (50)	0.0049
Numbness in the legs	8 (25)	17 (90)	<0.0001	8 (20)	6 (30)	>0.05
Decrease in pain perception	25 (78)	7 (37)	0.0032	37 (93)	11 (61)	0.011
Diabetes lasting >20 years	8 (25)	10 (53)	0.046	–	–	–
Insulin treatment	3 (9)	10 (53)	0.002	–	–	–
Rate of complications	10 (31)	17 (90)	0.0033	13 (33)	11 (61)	0.041

[a]Chi-square test

plain about more intense, localized pain and have a larger number of pain complaints than non-depressed patients [16, 4]. The prevalence of depression in our study was greater in the DG patients than in the CG patients (13% versus 3%) ($\times^2$=3.78, p=0.052), and all of them reported a poor outcome.

Another disease interfering with the severity of clinical presentation and possible level of satisfaction may be peripheral arterial disease. Its prevalence was significantly higher among diabetic patients (p=0.024), which makes it difficult to differentiate neurogenic from vascular claudication. The prevalence of peripheral vascular disease (PVD) was significantly greater in the DG (22%, 11/51) than in the CG (5%, 3/58; p=0.011, $\times^2$= 6.5). 64% (7/11) of the DG patients with PVD and all three of the CG patients with PVD reported poor satisfaction. This is in addition to the higher prevalence of neurogenic claudication which was significantly higher in the DG compared with the CG ($\times^2$=9.73; p=0.0018).

(b) Two previous studies came to different conclusions as to rates of satisfaction. One study [5] reported positive results (excellent and good) in 42% of DG patients and 91% of CG patients, while another study [17] could not show a statistically significant difference in the surgical outcome between DG and CG patients (72 and 80% of positive results, respectively). Satisfaction or dissatisfaction rates were somewhat more prevalent among female patients within each group, but otherwise there were no practical differences between the DG and CG. This is in contrast with our study showing significant differences between satisfied and non-satisfied DG patients. In diabetic patients, satisfaction or dissatisfaction were statistically associated with the ASA class, comorbidities (presence of osteoarthritis, peripheral arterial disease and depression), severity of clinical presentations (night pain, motor weakness or limb numbness), postoperative pain perception and rate of complications. The duration of diabetes and insulin use also differed between those satisfied and dissatisfied. In non-diabetics, there were significant differences between satisfied and non-satisfied patients with regards to preoperative motor weakness, presence of PVD, postoperative pain and postoperative rate of complications. These last two parameters seem to be the common factors associated with patients' satisfaction.

The findings of statistically significant associations between satisfaction and clinical severity in diabetic patients may be supported and explained by data from studies such as the Diabetes Control and Complications Trial [6]. That study showed that intensive insulin therapy, which successfully lowered the mean blood glucose over five years, reduced the risk of developing symptoms of diabetic neuropathy by 60%. Another study of 2, 405 Type 2 diabetic patients reporting poor glycemic control [11] showed that these patients were more than twice as likely to have symptoms of neuropathy than patients with good glycemic control. The fact that these patients were operated on at a more severe stenotic stage and had a longer conservative treatment could also explain the poorer results of surgery.

(c) The overall need for repeated surgery was similar to previous reports [18, 12]. However, the rate of re-operations was higher in the DG than in the CG, while the time interval between the surgical interventions was significantly shorter in the DG. Elimination only of a mechanical factor such as a protruded disc has, apparently, not stopped, but influenced the rate of progression of disease and the processes of neuroplasticity.

(d) Impaired lower extremity functioning and progressive walking difficulties in old age are important predictors of disability and loss of mobility, and are important constituents of frailty, a state characterized by clinical instability and decline in physiologic reserve [7, 9] and significant functional decline. Non-diabetic patients presented significant improvement in five ADL functions, compared with three in DG patients; meaning that functional improvement may be lower in diabetic patients undergoing surgery.

We conclude that decompression surgery for symptomatic spinal stenosis is beneficial in elderly diabetic patients. However, the results are related to successful pain reduction, physical and mental health status, severity of clinical presentation, insulin treatment and duration of diabetes mellitus. The benefits in diabetic patients are low, compared with non-diabetic patients, with regards to symptom relief, satisfaction, BADL function and rate of complications.

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