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Clinical and psychofunctional measures of conservative decompression surgery for lumbar spinal stenosis: a prospective cohort study

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Abstract Less invasive decompressive surgery has emerged as a logical surgical treatment alternative to wide decompression of spinal stenosis. The clinical outcomes of such conservative surgical treatment, however, are not well known. The aim of the study was to evaluate short-term psychometric and functional outcomes after conservative decompressive surgery for lumbar canal stenosis. Forty patients had a lumbar laminectomy procedure, which preserved the integrity of the neural arches, facet joints and most muscle attachments. Pre-operative clinical evaluation of the patients included: Waddell's non-organic signs (NOS) performed by an independent surgeon observer; three self-report questionnaires – the Waddell Disability Index (WDI), the Oswestry Low Back Pain Disability Questionnaire (ODI), and the Low Back Outcome Score (LBOS); and a general questionnaire that included a visual analog pain intensity scale (VAS). Post-operative clinical evaluations and questionnaires were obtained in 36 subjects (mean age 59.8 years) after a 1.7-year follow-up (range 1–2.6 years). Pre-operative versus post-operative statistical comparisons of the data were performed using adjusted error rates within families of predictors. Successful surgical outcome was de-

finied as an improvement in at least three of the following four criteria: self-reported pain on a VAS, self-reported functional status measured by LBOS, reduction of pain during walking and reduction of leg pain. At follow-up, there was a statistically significant improvement in VAS pain intensity, ODI, WDI, and LBOS. Patients classified as having mixed stenosis had a higher incidence of continuous pain symptoms in comparison with acquired stenosis, but there was no differential improvement with treatment depending upon stenosis classification and/or number of operative levels. Overall, 58% (21/36) of patients met the successful surgical outcome criteria, including 14 subjects who met all four success criteria. Based upon a stringent definition of successful surgical outcome, the results of a conservative laminectomy were as good as those of more aggressive decompressive procedures presented in the literature. Our findings indicate that, even in a highly organic disorder such as spinal stenosis, illness behavior plays an important role in predicting surgical outcome.

Keywords Lumbar vertebrae · Conservative treatment · Laminarthrectomy · Stenosis · Surgery

Introduction

Conservative treatment of lumbar spinal stenosis comprises physiotherapy, anti-inflammatory medications, lumbar corset and epidural infiltration, and it is generally accepted that surgery is indicated if a well-conducted, conservative management fails. The aim of the operation is to improve the quality of life. In recent publications from the Maine Lumbar Spine Study, Atlas and associates [4, 5] reported a greater improvement in patient recorded outcomes for surgically treated patients compared to non-surgically treated patients both at a 1- and a 4-year evaluation. In a prospective 10-year study, Amundsen et al. [2] found considerably better treatment results in a group of patients randomized for surgical treatment compared to a group randomized for conservative treatment. A meta-analysis of the literature showed that on average 64% of patients treated surgically for lumbar spinal stenosis were reported to have good-to-excellent outcomes [33].

Less invasive decompressive surgery has emerged as a surgical treatment alternative to wide decompressive laminectomy. One such procedure, *laminarthrectomy*, refers to a surgical decompression involving a partial laminectomy of the vertebra above and below the stenotic level combined with a partial arthrectomy at that level. This procedure spares anatomical structures and is believed to decrease the risk for post-operative instability [11, 19]. The clinical and biomechanical outcomes of laminarthrectomy, however, are not well known.

As evidence-based medicine becomes the norm, it is important to investigate all possible outcomes associated with a particular surgical procedure [25]. This study presents a comprehensive pre- and post-surgical clinical analysis combined with outcome measures for 36 consecutive patients undergoing decompressive lumbar laminarthrectomy without fusion. The aim was to evaluate the surgical outcome using both the clinical evaluation by an independent orthopedic surgeon observer and self-administered outcome scales. We hypothesised that stenosis patients would show significant improvement on patient self-reported health status and function and on clinical assessments.

Materials and methods

Patient selection

Between January 1996 and January 1998, consecutive patients presenting with clinically and radiologically confirmed lumbar spinal stenosis and admitted for surgery after a failed conservative treatment of a minimum of 1 year, were entered in the study. Patients who were admitted for similar surgery in the same period, but who had either a previous history of spinal surgery, or in whom spinal fusion was carried out as well, were excluded. Patients who underwent surgical decompression for degenerative spondylolisthesis were also excluded.

A total of 40 patients initially met the study inclusion criteria. However, several of these patients were excluded from the study. A 19-year-old young woman and a 71-year-old man were excluded

because they underwent fusion surgery during the year following the decompression. Two female patients, one aged 83 and the other aged 47 at the time of surgery, were excluded, as they did not return for the follow-up study. Thus, 36 patients (17 men and 19 women) were re-evaluated after a minimum follow-up of 1 year. The average time of follow-up was 1.7 ± 0.4 years (ranging from 1.0 to 2.6 years).

Pre-surgery

Clinical examination

The non-organic physical signs (NOS) according to Waddell et al. [35] were measured: tenderness, simulation tests, distraction tests, regional disturbances, and overreaction. These were recorded as a percentage: no positive sign scoring 0%, eight positive signs scoring 100%.

Computed tomography

Prior to surgery, standard lumbar spine radiographs were taken as well as 2-mm continuous and non-overlapping computed tomographic (CT) scan slices and/or myelo-CT scan slices (HiQ, Siemens, Erlangen, Germany). Based on the appearance of the pre-operative CT scans, the operated levels were classified as presenting congenital stenosis, acquired stenosis (due to degenerative changes), or mixed stenosis (partly congenital partly acquired), according to guidelines published by Airaksinen et al. [1].

Outcome assessments

Pre-operatively, the patients had to complete several self-administered questionnaires: the Waddell Disability Index (WDI) [34] and the Oswestry Low Back Pain Disability Questionnaire (ODI) [12] measured physical impairment. The Low-Back Outcome Score (LBOS) [14] and a general questionnaire, including personal and medical history, were administered.

Surgical technique

The partial laminectomy/arthrectomy or "laminarthrectomy" surgical procedure was performed by a single surgeon (R.G.). Specific details of the procedure can be found elsewhere [13, 36]. Briefly, patients are placed in ventral decubitus with a padded support at the level of the iliac crests and sternum. A very slight flexion of hips and knees ensures that the subjects lie in a lordotic position, simulating the normal erect posture [15]. After a midline posterior skin and subcutaneous tissue incision, the dissection goes through the dorso-lumbar fascia approximately 5 mm to the left of the midline, preserving the supraspinous ligamentous attachment to the fascia. The multifidus is detached from the left side of the spinous processes and laminar attachments. An osteotomy is performed with a curved osteotome at the base of the spinous processes of the vertebrae above and below the stenotic levels, just superficially to their junction with the laminae. Flavectomies are carried out and the superior and inferior laminae are partially resected. Partial facetectomies and foraminal decompressions are carried out under direct vision with the aid of Kerrison rongeurs and/or a power drill.

After completion of a thorough decompression, the dorso-lumbar fascia is resutured over a suction drain to the supraspinous ligamentous/fascial complex, with the osteotomized spinous processes regaining their initial positions over the neural arches.

Surgical follow-up

The subjects underwent an identical standard clinical evaluation by the independent orthopedic surgeon observer (K.V.) as prior to surgery. At no other time did the patients see the independent observer, who was not involved in the patient care. During the follow-up visit, the patients completed the same self-administered questionnaires. In addition, the patients completed a questionnaire that included three questions concerning their surgical treatment experience:

1. Were you happy with the care you received during your hospital stay?
2. Were you happy with the operation itself?
3. Would you have the same operation again?

Defining a successful outcome

Predicting successful outcome requires a precise definition thereof. As demonstrated by Howe and Frymoyer [18], different definitions of success can result in widely differing conclusions about the efficacy of a given surgical procedure. Although this admonition has been in the spine literature for at least 15 years, no solution in terms of standardized methods for defining successful treatment outcomes has been accepted. In this study, a paradigm for successful outcome of surgical treatment of patients presenting with acquired or mixed stenosis was defined in terms of four variables. Two of these were general health outcome measures:

1. Patient self-reported pain, as measured on a single-item pain intensity visual analog scale (VAS), ranging from "no pain" to "unimaginable pain", with scores rated from 0 to 100, and
2. Patient self-reported functional status, as measured by the LBOS.

Two other measures more specific for stenosis were defined as:

3. Reduction of pain during walking, and
4. Reduction of leg pain.

A patient was considered a success if her/his pre-operative to post-operative treatment assessment on these four measures demonstrated improvement on at least three of the four outcomes.

Statistical analysis

Controlling for inflated error rates

As with most clinical trial studies, the number of variables gathered is often greater than the number of patients studied. Thus, a large number of statistical tests can be performed, which is known to cause inflation in the type I error rate or the probability of observing statistical significance by chance. By definition, a type I error rate of 0.05 means that, with a true null hypothesis, there is a 5/100 (a 1 in 20) chance that the observed difference was due to chance differences rather than a true reflection of real differences. When one adds concerns for inflated type I error rates to the general lack of power inherent in many clinical studies, the clinical researcher is confronted with a difficult statistical problem. In this study, a compromise between maximizing power and minimizing the effects of inflated type I error rate was made by incorporating a statistical strategy that involved adjusting error rates within families of predictors to obtain a nominal error rate [7]:

$$\alpha_N = 1 - (1 - \alpha_{FW})^{1/k} \quad (1)$$

where α_N is the nominal error rate, α_{FW} is the family-wise error rate, and k is the number of comparisons.

Treatment efficacy

To evaluate treatment efficacy, patient age at time of surgery, gender and diseases variables such as classification of stenosis and the number of operative levels (dichotomized as one level vs two or more) were considered in conjunction with changes in health status following surgery. Treatment efficacy was evaluated within a three-variable crossed factorial design, considering stenosis classification, number of operative levels, and changes in outcomes from pre- to post-operative assessment using mixed model analysis of variance (ANOVA) techniques.

For continuous outcomes, mixed model analysis of variance and covariance methods were used. For discrete outcomes, repeated measures categorical data modeling techniques were used, since traditional chi-square procedures required independence between levels of predictors and, in this case, the pre-post surgery assessments violate this assumption.

Results

Table 1 and Table 2 summarize patient demographics and provide statistical comparisons across relevant demographics. Mean age at the time of surgery was 59.8 years (SD 16.8 years), ranging from 17.3 to 84.1 years. Fifty percent of the patients reported no co-morbidities, three patients reported diabetes, two rheumatoid arthritis, four cardiac disease, one gout, and six reported various conditions. Calcification of the aorta, identified from CT scan, was noted in 50% of the patients (18/36). There were ten active smokers in the series (four women and six men).

In 21 subjects (58.3%) the stenosis was classified as acquired, in one (2.8%) as purely congenital, and in 14 (38.9%) it was classified as a combination of acquired and congenital narrowing. For the analysis of the data, the one congenital case was added to the mixed group.

Overall, personal and health demographics did not show much inter-relationship. Although female subjects were significantly older than male subjects at the time of operation ($P < 0.05$), gender was not significantly related to any other personal or health-related demographic. Stenosis classification was significantly related to only one health-related demographic: patients classified with mixed stenosis had a higher incidence of continuous pain compared to patients with acquired stenosis ($P < 0.04$).

One-level decompression was performed in 10 subjects, two-level decompression in 16, three-level decompression in 5, four-level in 1 and five-level decompression in 4 subjects. One female patient with acquired, multiple-level stenosis had a total facetectomy at one level and one male patient with mixed, multiple-level stenosis had a dural tear.

The average duration of the operation was 68 ± 33 min (ranging from 30 to 150 min) and the length of hospital stay averaged 6.0 ± 4.9 days (ranging from 2 to 29 days). With the exception of days in hospital, there were no significant differences across these surgical factors relative to stenosis classification, number of operative levels or gender. For days in the hospital, female patients had sig-

Table 1 Patient and clinical demographics, by gender

Variable	Overall	Males (N=17)	Females (N=19)	P-value
Age at time of operation (n=36)	59.8±16.8	54.0±19.7	64.9±12.1	0.05
Years with symptoms (n=33)	3.4± 5.2	2.5± 3.7	4.4± 6.3	0.30
Continuous pain				0.18
Yes	19 (53%)	11 (65%)	8 (42%)	
No	17 (47%)	6 (35%)	11 (58%)	
Stenosis type				0.54
Acquired	21 (58%)	9 (53%)	12 (63%)	
Mixed	15 (42%)	8 (47%)	7 (37%)	
No. of operative levels				0.60
1	10 (28%)	4 (24%)	6 (32%)	
2+	26 (72%)	13 (76%)	13 (68%)	
Co-morbidities				0.14
None	18 (50%)	12 (71%)	6 (32%)	
1	11 (31%)	3 (18%)	8 (42%)	
2 or more	4 (11%)	1 (6%)	3 (16%)	
Missing	3 (8%)	1 (6%)	2 (10%)	
Aorta calcification				0.74
Yes	18 (50%)	8 (47%)	10 (53%)	
No	18 (50%)	9 (53%)	9 (47%)	
Smoker				0.42
Yes	10 (28%)	6 (35%)	4 (21%)	
No	23 (64%)	9 (53%)	14 (74%)	
Missing	3 (8%)	2 (12%)	1 (5%)	

Table 2 Patient and clinical demographics, by type of stenosis

Variable	Overall	Acquired (N=21)	Mixed (N=15)	P-value
Age at time of operation (n=36)	59.8±16.8	61.5±13.9	57.3±20.6	0.47
Years with symptoms (n=33)	3.4± 5.2	4.3± 6.3	2.3± 3.1	0.30
Continuous pain				0.04
Yes	19 (53%)	8 (38%)	11 (73%)	
No	17 (47%)	13 (62%)	4 (27%)	
No. of operative levels				0.11
1	10 (28%)	8 (38%)	2 (13%)	
2+	26 (72%)	13 (62%)	13 (87%)	
Co-morbidities				0.72
None	18 (50%)	11 (52%)	7 (47%)	
1	11 (31%)	5 (24%)	6 (40%)	
2 or more	4 (11%)	3 (14%)	1 (7%)	
Missing	3 (8%)	2 (10%)	1 (7%)	
Aorta calcification				0.74
Yes	18 (50%)	11 (52%)	7 (47%)	
No	18 (50%)	10 (48%)	8 (53%)	
Smoker				0.51
Yes	10 (28%)	7 (33%)	3 (20%)	
No	23 (64%)	13 (62%)	10 (67%)	
Missing	3 (8%)	1 (5%)	2 (13%)	

Table 3 Summary of outcome measures' internal consistencies and inter-correlations for both the pre-treatment and post-treatment assessments [*MSPQ* Modified Somatic Perception Questionnaire (13 items), *SDS* Zung Self-Rating Depression Scale (20 items), *WDI* Waddell Disability Index (9 items), *NOS* Waddell Non-Organic Signs (8 items), *ODI* Oswestry Disability Index (10 items),

LBOS Greenough Low-Back Outcome Score (13 items)]. All instruments are scaled such that higher values represent illness, except for the *LBOS*. Bold figures on the diagonal report coefficient alpha internal consistency reliabilities (the pre-treatment value followed by the post-treatment value). Correlations greater than 0.35, or less than -0.35 were significant at $P < 0.05$ or more

Pre-treatment	Post-treatment					
	<i>MSPQ</i> ($n=36$)	<i>SDS</i> ($n=36$)	<i>WDI</i> ($n=36$)	<i>NOS</i> ($n=36$)	<i>ODI</i> ($n=23$)	<i>LBOS</i> ($n=36$)
<i>MSPQ</i> ($n=24$)	0.70, 0.74	0.48	0.45	0.37	-0.03	-0.55
<i>SDS</i> ($n=22$)	0.66	0.84, 0.80	0.50	0.21	-0.06	-0.57
<i>WDI</i> ($n=34$)	0.49	0.70	0.72, 0.45	0.47	0.50	-0.75
<i>NOS</i> ($n=32$)	0.35	0.43	0.36	0.80, 0.84	0.17	-0.44
<i>ODI</i> ($n=34$)	0.11	0.31	0.29	-0.02	0.72, 0.68	-0.17
<i>LBOS</i> ($n=35$)	-0.51	-0.64	-0.51	-0.07	-0.35	0.81, 0.46

nificantly longer stays than male patients (7.6 ± 6.2 days vs 4.2 ± 1.6 days, $P < 0.026$). There were no significant differences in hospital stay relative to stenosis classification, number of operative levels or gender.

Of the 34 patients who responded to the satisfaction questionnaire, 94% (32/34) were happy with the care administered during their hospital stay, 97% (33/34) reported satisfaction with the operation itself, and 65% (22/34) indicated they would undergo the same operation again. No statistically significant differences were observed for subgroups based on gender, operative age, stenosis classification or number of operative levels. However, of the patients who underwent a one-level decompression, 89% (8/9) reported that they would have the operation again compared to 56% (14/25) of patients who had multi-level decompressions.

Table 3 summarizes the outcome measures' internal consistencies and inter-correlations at both the pre- and post-

treatment assessments. In general, internal consistency reliability estimates were similar to those reported in the literature. Pre- and post-treatment assessments were generally of similar reliabilities, and the structure of inter-correlations between the different outcomes was generally consistent with each instrument's scaling, and supportive of the similarity of these constructs to an underlying notion of general health.

Figure 1 summarizes patient pre- to post-treatment measures on the self-reported scales as well as on the *NOS*. Four self-reported outcomes were considered to evaluate improvement after surgery: pain intensity (*VAS*), the *ODI*, the *WDI*, and the *LBOS*. Applying equation (1) to adjust for the effects of multiple testing indicated that a family-wise type I error rate of 0.05 would require nominal alphas (P -values) of less than 0.013. All of these four outcomes demonstrated statistically significant pre- to post-operative changes consistent with improved health status, namely

Fig. 1 Summary of pre- to post-surgery changes for seven patient self-reported outcomes (*MSPQ* Modified Somatic Perception Questionnaire, *SDS* Zung Self-rating Depression Scale, *NOS* Waddell's non-organic symptoms, *VAS* visual analog pain intensity scale, *WDI* Waddell Disability Index, *ODI* Oswestry Disability Index, *LBOS* Greenough Low Back Outcome Score)

* Indicates too many missing values between Pre- and Post- Assessments to make reasonable inferences

Table 4 Successful outcome, defined as improvement on at least three of four outcome domains: improved pain (VAS), improved function (LBOS), reduced pain during walking and reduced leg pain

Improved		Reduced pain during walking			
Pain	Function	Yes		No	
		Reduced leg pain		Reduced leg pain	
		Yes	No	Yes	No
Yes	Yes	14S	4S	0	3
Yes	No	2S	3	2	0
No	Yes	1S	2	0	1
No	No	2	2	0	0

S=successful outcome

VAS pain intensity (65.9 ± 21.4 pre to 36.1 ± 30.6 post, $P < 0.004$), the ODI (42.07 ± 14.4 pre to 30.9 ± 18.7 post, $P < 0.0031$), the WDI (4.98 ± 1.90 pre to 3.56 ± 2.25 post, $P < 0.0034$), and the LBOS (28.1 ± 9.8 pre to 39.6 ± 16.8 post, $P < 0.005$). There were no significant effects found for any of the outcomes consistent with a hypothesis of differential improvement with treatment that depended on stenosis classification and/or number of operative levels. Waddell's NOS also demonstrated a pre- to post-operative reduction or improvement, but this change did not meet the statistical significance criterion.

Of the 36 patients, 14 demonstrated improvement on all four surgical success criteria and 7 on three of the four criteria. Therefore, 21 of 36 (58.3%) were classified as successful outcomes (Table 4). Of the 15 who did not demonstrate sufficient improvement to be labelled a success, 12 reported improvement in two categories and 3 reported improvement in one category. For the three patients who reported a single success, two reported improvement in walking, and the third in function.

Discussion

In this study, we report the short-term (1- to 2.6-year) outcomes of a conservative surgical treatment for lumbar spinal stenosis. In a prospective long-term follow-up study of 146 lumbar spinal stenosis patients reviewed between 1 and 11 years after laminectomy, Javid and Hadar [19] did not find statistical differences in outcome between the 1-year and 1- to 11-years follow-up. Therefore, we consider the follow-up period in this prospective study to be representative of an adequate short-term follow-up.

The use of wide decompressive procedures for spinal stenosis, without regard for the integrity of the laminae and facet joints and without preservation of the spinous processes and interspinous ligaments, may lead to mechanical failure of the spine and a chronic pain syndrome.

Hence, wide decompressive procedures are often combined with fusion [8]. A number of recent studies have reported on less aggressive surgical techniques that provide for adequate decompression [3, 6, 8, 11, 16, 21, 22, 24, 28, 32, 37]. These procedures have been described as fenestration, laminotomy, selective decompression and laminarthrectomy, and are purported to improve post-operative morbidity, provide early mobility, and to reduce hospital stay. Conservative surgical decompression maintains spinal stability, since tissue disruption is minimized and the decompression carried out without violating the integrity of the laminae, facet joints and interspinous ligaments. In accordance with the current general tendency towards minimally invasive surgery, the present study utilized a conservative surgical technique that preserved much of the anatomy and function of the lumbar spine. Our results did not show differences as measured by the standardized outcome instruments for patients operated at a single level in comparison to patients having undergone multi-level decompression. Yet, in their self-reported satisfaction evaluation about the surgery, there was a marked difference between those two. This former is consistent with the results obtained by Quigley et al. [27], who found that outcome did not correlate with the number of levels decompressed. According to Katz et al. [20], however, single-level laminectomy is a risk factor for poor outcome. In the light of the work of Porter and Ward [26], it may be argued that two- or more level stenosis cases respond to decompression by suppressing the venous blood pooling, whereas in one-level cases, other factors may contribute to the clinical presentation. Our results do not support this argument. Using a model-building decision algorithm, Gunzburg and associates [16] recently reported that underlying subclinical vascular factors such as aorta calcification are potential mitigators of success.

The current study utilized a number of self-administered questionnaires to assess patient physical impairment and general health perceptions. Physical impairment or disability was assessed using the ODI, LBOS and WDI instruments. In a series of 32 patients surgically treated for spinal stenosis, Tenhula and associates [31] recently reported a statistically significant improvement in patient function using the ODI. Our study also shows that general function and disability questionnaires designed for low back pain are efficient in the follow-up of surgery for spinal stenosis. In terms of disability assessment, however, instruments such as the ODI are not well-designed to assess specific disability associated with lumbar spinal stenosis. Some investigators [23] have also stated that the ODI is not sensitive enough to assess disability in lumbar spinal stenosis surgery. On the other hand, the ODI as well as the WDI and the LBOS instruments showed a marked improvement following surgery in our series of patients. Thus, it appears that the instruments designed for and commonly used in low back pain can be used to assess outcome of surgical treatment of spinal stenosis.

Commonly used instruments to assess patient health status also include the VAS and NOS. Tenhula et al. [31] reported that the VAS improved from 78/100 pre-operatively to 20/100 at the 1-year follow-up. Our results were less dramatic, but were still highly significant. Interestingly, the NOS instrument showed a higher than expected rate of non-organic symptoms in our group of patients, since stenosis patients have an anatomic condition. However, there was no significant change from the pre-operative value. The NOS is generally thought to be an indicator of illness behavior rather than being related to function. Hence, a change in the NOS would not necessarily be expected to significantly improve in diseases with a true organic pathology such as lumbar spinal stenosis.

Stucki et al. [29] published a self-administered spinal stenosis questionnaire (SSS), which Deo et al. [9] compared with other instruments, including the ODI. They found that existing questionnaires were broadly similar to the SSS and also noted that, while the SSS was more precise, it was not much better than the ODI. The SSS was not used in the present prospective study, as it was unavailable at the start of the study, but should be considered in future studies examining spinal stenosis.

Overall, the health belief recorded in the general questionnaire of this study is consistent with findings published in the literature. In a Belgian population study, Szpalski et al. [30] found that back pain sufferers consider themselves to be in generally good health, but also noted that patients who had undergone surgery had a lower

opinion of their general health status in comparison to those who had not undergone surgery. As emphasized by Dunt et al. [10], there is a potential discrepancy between the patient's perception of her/his function and the physician's assessment of that function. This discrepancy between patient's perception and physician's assessment may lead to an underestimation of the patient's disability by the physician. Both are indeed valid, and this is why they should be combined. With this in mind, a successful outcome was defined in this study by a combination of pain and function variables, and required improvement in at least three out of four criteria: improvement in the VAS, LBOS, pain during walking, and reduction in pain radiating to the lower extremities. Based on these more stringent outcome criteria, the success rate of the laminarthrectomy procedure was 58.3%. This is consistent with success rates reported in the literature [33], and is better compared to non-surgical treatment [2, 3, 4], but our overall outcome results still leave a number of patients with little improvement from the point of view of pain and function. Whereas the use of outcome measures has become standard practice in spinal fusion surgery, this is not the case for spinal stenosis surgery. Our results support the need to use validated outcome instruments in spinal stenosis surgery.

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