Original article

Lumbar spinal stenosis: Which predictive factors of favorable functional results after decompressive laminectomy?

La sténose lombaire : quels sont les facteurs prédictifs de résultats fonctionnels favorables après laminectomie ?

E. Fouloungne a, S. Derrey b, M. Ould Slimane a, S. Levèque a, A.-C. Tobenas b, F. Dujardin a, P. Fréger b, P. Chassagne c, F. Proust b,∗

a Department of orthopedics, Rouen university hospital, 1, rue de Germont, 76091 Rouen cedex, France
b Department of neurosurgery, Rouen university hospital, 1, rue de Germont, 76091 Rouen cedex, France
c Department of geriatrics, Rouen university hospital, 1, rue de Germont, 76091 Rouen cedex, France

A R T I C L E   I N F O

Article history:
Received 18 June 2012
Accepted 16 September 2012

Keywords:
Lumbar spinal stenosis
Decompressive laminectomy
Long-term functional outcome
Predictive factor

A B S T R A C T

Background and purpose. – Long-term results of decompressive laminectomy in degenerative lumbar stenosis have been studied in only six prospective studies. The objective of our study was to evaluate the functional outcome at long term of patients after decompressive laminectomy in lumbar stenosis and to determine predictive factors of favorable outcome.

Methods. – A prospective cohort data were collected by an independent observer five years after decompressive laminectomy for degenerative lumbar stenosis. The endpoint was the assessment of the Beaujon score for functional evaluation. The result was considered as favorable if the Beaujon score increased by at least five points between the preoperative stage and at follow-up examination. Logistic regression was then performed with univariate and multivariate analysis to reveal predictive factors of good long-term outcome (P ≤ 0.05).

Results. – The preoperative characteristic of our population (n = 98) was a mean age of 67.3 ± 8.8 years, a low comorbidity (mean Charlson score = 2.8 ± 1.5), overweight status (BMI = 29.4 ± 6.3) and the mean Beaujon score was 9.3 ± 3.1. At five years after surgery, the mean Beaujon score became 14.1 ± 4.2. Favorable functional outcome concerned 45.9% of our series. The predictive factor of favorable outcome identified in the univariate analysis the neurological deficit (P = 0.05) and in the multivariate analysis the low comorbidity (P = 0.01).

Conclusion. – The long-term results of surgical treatment of lumbar spinal stenosis were moderate with an improved outcome in 49.5% of cases in our study. The only independent factor to a favorable outcome was the low comorbidity.

© 2012 Elsevier Masson SAS. All rights reserved.

R É S U M É

Contexte et objectif. – Les résultats à long terme de la décompression en cas de sténose lombaire dégénérative ont été étudiés dans seulement six études prospectives. L’objectif de notre étude était d’évaluer les résultats fonctionnels à long terme de patients opérés d’une sténose lombaire et de déterminer les facteurs prédictifs d’un résultat favorable.

Méthodes. – Les données postopératoires ont été recueillies de façon prospective par un observateur indépendant, cinq ans après la décompression. Le résultat a été considéré comme favorable si le score de Beaujon avait augmenté de cinq points au minimum entre le stade préopératoire et le terme du suivi. Une régression logistique a été réalisée afin de révéler des facteurs prédictifs de bon résultat à long terme (P ≤ 0.05).

Résultats. – La caractéristique de notre population (n = 98) en préopératoire était un âge moyen de 67.3 ± 8.8 ans, une comorbidité faible (score de Charlson = 2.8 ± 1.5), une surcharge pondérale

1. Introduction

Degenerative lumbar spinal stenosis is a very common compressive pathology to the spinal canal, the neuronal foramina and the nerve roots responsible for frequent surgical indication in patients past 65 years (Katz et al., 1999). Although numerous studies have been published, controversy still exists regarding the indication of surgical treatment (Athiviraham et al., 2011; Gibson and Waddell, 2005). During the last years, studies with high evidence have been published and report that the majority of the patients benefit from surgery both in reducing pain and improving function, faster and in larger extent than the conservative treatment approach (Atlas et al., 2005; Malmivaara et al., 2007; Weinstein et al., 2008). Indeed, surgery is required after the failure of conservative care (Jonsson et al., 1998). The literature shows heterogeneous results after the surgical treatment of spinal stenosis. In the short term, several prospective studies reported a functional benefit in 60 to 79% of cases (Amundsen et al., 2000; Gelalis et al., 2010; Iguchi et al., 2000; Javid and Hadar, 1998; Jonsson et al., 1998; Katz et al., 1999; Thornes et al., 2011). Few studies have examined long-term functional outcome of surgical treatment of degenerative lumbar spinal stenosis with a high variability of results (Amundsen et al., 2000; Atlas et al., 2005; Iguchi et al., 2000; Javid and Hadar, 1998; Jonsson et al., 1998; Yamashita et al., 2003). A meta-analysis conducted by Turner et al. reported a good outcome in a large range 26 to 100% (Turner et al., 1992). Moreover, predictive factors influencing long-term results are contradictory and poorly studied in the literature (Aalto et al., 2006; Atlas et al., 2005; Iguchi et al., 2000; Jonsson et al., 1998; Turner et al., 1992; Yamashita et al., 2003). The study of these criteria is a key issue to determine the best timing to propose the surgical management.

The objectives of this study were to evaluate in the long term setting the functional outcome after the surgery of lumbar spinal stenosis, and to determine predictive factors to a favorable outcome.

2. Patients and methods

2.1. Study design

This study involved a series of consecutive patients operated on for a degenerative lumbar stenosis. The goals were to analyze the functional outcome at five years and determine predictive factors of favourable outcome.

2.2. Population

The criteria for inclusion were:

- the lumbar spinal stenosis was defined by the presence of intermittent neurogenic claudication, or signs of chronic neurogenic compression and associated with the presence of a central or lateral compression of the cauda equina or spinal nerves on imaging;
- patients treated surgically of a degenerative lumbar spinal stenosis between January 2003 and December 2004 in the Department of Neurosurgery at Rouen University Hospital;
- control consultation in out-clinic patient in 2009 to prospectively evaluate the functional status and quality of life, by an independent physician.

The criteria of exclusion were:

- associated pathology responsible for functional disability (cervical myelopathy, peripheral neuropathy, cerebrovascular accident, peripheral arterial disease stage 2–4 according to the Leriche and Fontaine, inflammatory rheumatoid disease);
- a previous history of lumbar canal decompression.

Among the 143 eligible patients, 11 were excluded and 34 lost to follow-up. In total, 98 patients were included.

2.3. Endpoint

The functional outcome was graded according to the Beaujon score (Lassale et al., 1988). Questions covered the following topics: walking distance (three points), low back pain (three points), radicular pain at rest (three points) and radicular pain during motion (two points), neurological deficit (four points), analgesia (two points) and daily life (three points). The maximum possible score of 20 points is given to a subject with no functional impact.

2.4. Surgical treatment

Patients were placed in prone position. The median incision was centered on the spinous processes. Laminectomy was performed in all cases by a senior surgeon using a Kerrison punch. The lateral spinal canal decompression was performed thanks to a partial arthrocentomy associated to small foraminotomy to free the nerve roots. Zygapophysal facet joints were preserved up to avoid a secondary destabilization. The hypertrophied ligamentum flavum was resected too using a Kerrison punch. Concomitant discectomy was performed in patients with an associated herniated disc. One patient underwent internal fixation combined with a laminectomy but no fusion had been achieved. The average time of surgery was 90 ± 11 minutes and the intraoperative blood loss averaged 115 mL ± 23 mL.

Two days after surgery patient were allowed to walk without orthesis with a sufficient analgesia. Rehabilitation performed by a physiotherapist consisted in isometric tonification of the lower limbs and trunk. It was started in the ward. At home (about five days), active physical therapy was also prescribed.

2.5. Variables

Pre- and peroperative variables were collected retrospectively through the study of the clinical records of each patient. The variables identified preoperatively were biometric information (sex, age, BMI), walking distance, dominant symptom pain,
presence of a sensory or motor neurological impairment, current functional status (Beaujon score), comorbidity (Charlson score; Charlson et al., 1987), radiological analysis of lumbar spinal stenosis (the anteroposterior diameter of the spinal canal in a horizontal section of CT or MRI [sequence T1 or T2] through the transverse processes), the diameter of the paravertebral muscles (measured in horizontal section on CT or MRI [sequence T1 or T2]), number of involved levels and localisation of stenosis (global or lateral), operating criteria with the number and localisation of the recalibrated levels, presence of osteosynthesis and/or arthrodesis and revision surgery.

Five years after surgery, patients were reassessed (average of 65 ± 6 months) during a medical examination with an independent observer. The entourage was present and the consultation lasted about 30 minutes. Analysed variables were biometric information (sex, age, BMI), walking distance and functional status (Beaujon score).

2.6. Statistical analysis

Descriptive statistics were performed using JMP (version 6.0.3, SAS Institute Inc.). Quantitative variables (age, BMI, Beaujon score, walking distance, Charlson score, measuring the diameter of the spinal canal on imaging, number of levels reached and recalibrated) considered as continuous numeric variables were expressed as mean ± standard deviation (SD) and compared using the Student t test. Some variables (age ± 67 years, BMI ± 30, Beaujon score ± 10, Charlson score ± 3, the walking distance ± 500 m, the spinal canal diameter ± 1.4 cm, the muscle diameter ± 3.91 cm, the number of levels achieved and recalibrated ± 2) were dichotomized. Other values were qualitative such as gender, predominant symptom (back pain or radiculopathy), the presence of neurological deficit, type of stenosis (global or lateral), the levels or recalibrated, the presence of fusion and/or fixation and the concept of early recovery or re interventions within five years. These values were expressed as proportion and compared with that a χ² test or a Fisher’s exact test.

The outcome was considered as favorable when a score of Beaujon improved by at least five points between the preoperative period and five years reassessment.

An odds ratio in univariate and multivariate analysis with a confidence interval of 95% was estimated using logistic regression to determine predictors of favorable functional outcome at five years of canal recalibration for symptoms of spinal stenosis. The variables tested were age, BMI, Beaujon score, walking distance, dominant symptom, presence of a neurological deficit, Charlson score, diameter of the spinal canal, diameter of the paravertebral muscles, number and localisation of levels achieved and the number and location of levels recalibrated. The statistical significance is assigned a value of P < 0.05.

3. Results

3.1. Population

As detailed in Table 1, the mean age of patients at the time of surgery was 67.3 ± 8.8 years with as many men as women (sex ratio at 0.96). In addition, comorbidity was low with an average Charlson score of 2.8 ± 1.5. Patients were predominantly overweight with a mean BMI measured at 29.4 ± 6.3.

The functional status was characterized by a Beaujon score (score/20) of 9.3 ± 3.1 with most often lumboradiculagia (88.8%). Half of the patients had a neurological deficit (51%).

The morphological analysis of the stenosis reached mainly two (45.9%) or three (42.8%) levels. L4 was consistently reached

Table 1
Socioeconomic characteristics, functional, comorbidity, iconographic and operating data about a population of 98 patients undergoing a decompressive laminectomy in a degenerative lumbar stenosis.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n = 98 (%)</th>
<th>Median; range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Socio-demographic data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in years preoperatively (mean ± SD)</td>
<td>67.3 ± 8.8</td>
<td>68; 41–84</td>
</tr>
<tr>
<td>Sexe ratio (M/F)</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>CHARLSON score (mean ± SD)</td>
<td>2.8 ± 1.5</td>
<td>3; 0–8</td>
</tr>
<tr>
<td><strong>Clinical data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative BMI (mean ± SD)</td>
<td>29.4 ± 6.3</td>
<td>29; 19.5–53.3</td>
</tr>
<tr>
<td>Preoperative walking distance in m (mean ± SD)</td>
<td>670.6 ± 1269.7</td>
<td>1000; 0–5000</td>
</tr>
<tr>
<td>BEAULON preoperative score (mean ± SD)</td>
<td>9.3 ± 3.1</td>
<td>9; 2–19</td>
</tr>
<tr>
<td>Predominant symptom: radicular/back pain</td>
<td>77 (88.3)/11 (11.2)</td>
<td></td>
</tr>
<tr>
<td>Neurological deficit</td>
<td>48 (51)</td>
<td></td>
</tr>
<tr>
<td><strong>Characteristics of the stenosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductal diameter in cm (mean ± SD)</td>
<td>1.4 ± 0.6</td>
<td>1.3; 0.46–3.78</td>
</tr>
<tr>
<td>Levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of levels: 2/3/4/5 (mean ± SD)</td>
<td>45 (45.9)/42 (42.8)/10 (10.2)/1 (1)</td>
<td>2.6 ± 0.7</td>
</tr>
<tr>
<td>Topography: L2/L3/L4/L5/Other</td>
<td>21 (21.4)/22 (73.5)/98 (100)/63 (64.3)/6 (6.1)</td>
<td></td>
</tr>
<tr>
<td>Type of stenosis: Lateral/Global</td>
<td>7 (7.1)/91 (92.9)</td>
<td></td>
</tr>
<tr>
<td>Diameter of the muscles in cm (mean ± SD)</td>
<td>4.01 ± 0.9</td>
<td>3.91; 2.71–5.6</td>
</tr>
<tr>
<td><strong>Operating data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levels recalibred</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of levels: 1/2/3/4/5 (mean ± SD)</td>
<td>2 (2.04)/47 (48)/40 (40.8)/8 (8.2)/1 (1)</td>
<td>2.6 ± 0.7</td>
</tr>
<tr>
<td>Topography: L2/L3/L4/L5/Other</td>
<td>20 (20.4)/72 (73.5)/97 (99)/61 (62.2)/2 (2)</td>
<td></td>
</tr>
<tr>
<td>Arthrodesis or osteosynthesis</td>
<td>1 (1)</td>
<td></td>
</tr>
<tr>
<td>Complication</td>
<td>4 (4.1)</td>
<td></td>
</tr>
<tr>
<td>Recomposition</td>
<td>10 (10.2)</td>
<td></td>
</tr>
<tr>
<td>Stenosis adjacent levels</td>
<td>7 (7.1)</td>
<td></td>
</tr>
<tr>
<td>Spinal destabilization</td>
<td>3 (3.1)</td>
<td></td>
</tr>
</tbody>
</table>

BMI: body mass index; M/F: male/female; m: meter; cm: centimeter; Ln: number of lumbar vertebrae; SD: standard deviation.

BMI: indice de masse corporelle; M/F: homme/femme; m: mètre; cm: centimètre; Ln: nombre de vertèbres lombaires; SD: écart-type.
(100%) then L3 (73.5%) and L5 (64.3%). The narrowing of the canal averaged 1.4 ± 0.6 cm and the stenosis was mainly global (92.9%). The diameter of the paravertebral muscles averaged 4.01 ± 0.9 cm.

In majority, two (48%) or three (40.8%) levels were recalibrated. L4 was almost constantly recalibrated (99%) and L3 (73.5%), L5 (62.2%) were also frequently recalibrated. A single fixation without arthrodesis had been achieved in our series for a significant L4-5 L5 instability diagnosed preoperatively on dynamic radiographs. Four patients (4.1%) had an early complication requiring further surgery (three local infections). An early complementary laminectomy at L3, L4 was performed in one case due to an insufficient recalibration with residual postoperative pain. The rate of further surgery within five years performed beyond three months post-surgery was 10.2% and was achieved on average 43 ± 5 months after the first intervention. The causes of further surgery were seven cases of stenosis of adjacent levels (7.1%) responsible for clinical deterioration. Levels that were involved were L5 in two cases, L3 in three cases and L2 in two cases. Three (3.1%) delayed spinal required revision surgery for pedicle screw fixation and posterolateral fusion. The diagnosis of instability was highlighted by a recurrence of pain or neurological disorders and radiological confirmation. Instability involved the levels L4-L5 in two cases and L3-L4 in one case.

### 3.2. Functional status at five years

The characteristics of patients at five years are detailed in Table 2.

Postoperative BMI was comparable to the preoperative BMI (P = 0.23). Functional status was significantly improved compared to the initial status for walking distance (P = 0.001) and Beaujon score (P = 0.001). According to our criteria for a good outcome, 45 (45.9%) patients experienced a significant improvement in their functional status.

### 3.3. Predictive factors of outcome

The study of predictors is presented in Table 3. The only predictive factor that appeared significant in a multivariate analysis was a Charlson score of less than 3 with an OR 4.58 (95% CI: 1.37 to 17.48) (P = 0.01). In a univariate analysis, predictive factors identified was a lower comorbidity with an OR = 4.35 (95% CI: 1.67–11.33) and the

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Comparison of functional variables and quality of life between the preoperative clinical condition and clinical status at five years of decompressive laminectomy in a degenerative lumbar stenosis.</th>
<th>Comparaison des variables fonctionnelles et de la qualité de la vie entre l’état clinique préopératoire et le statut clinique à cinq ans d’une laminectomie décompressive pour sténose lombaire dégénérative.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent variable</td>
<td>Preoperative</td>
<td>At 5 years</td>
</tr>
<tr>
<td></td>
<td>Mean ± SD [median; range]</td>
<td>Mean ± SD [median; range]</td>
</tr>
<tr>
<td>BMI</td>
<td>29.5 ± 6.3 [29; 19.5–53.3]</td>
<td>29.3 ± 6.4 [28.4; 18–53]</td>
</tr>
<tr>
<td>Walking distance (m)</td>
<td>705.6 ± 1303.58 [1000; 0–5000]</td>
<td>2083.3 ± 2131.6 [1000; 48–5000]</td>
</tr>
<tr>
<td>Beaujon score</td>
<td>4.01 ± 3.07 [9; 2–19]</td>
<td>14.1 ± 4.2 [14; 3–20]</td>
</tr>
<tr>
<td>EORTC score</td>
<td>NA</td>
<td>20.1 ± 5.9 [19; 13–44]</td>
</tr>
</tbody>
</table>

BMI: body mass index; m: meter; SD: standard deviation; NA: not applicable.
BMI: indice de masse corporelle; m: mètre; SD: écart-type; NA: ne s’applique pas.

* Student test.
* Test de Student.

presence of neurological deficit ($P = 0.05$) with OR 2.32 (95% CI: 1.03 to 5.23).

4. Discussion

Our study is a retrospective study with prospective follow-up of 98 patients assessed during five years after a procedure of surgical decompression of a degenerative lumbar stenosis. It concluded to a significant improvement in the Beaujon score that increased from 9.3 ± 3.1 preoperatively to 14.1 ± 4.2 to five years ($P = 0.001$). The predictive factors of favorable outcomes were the low comorbidity ($P = 0.002$) and presence of preoperative neurological deficit ($P = 0.04$).

4.1. Long-term interest of decompressive laminectomy

The appreciation of the benefits of decompressive laminectomy for degenerative lumbar stenosis remains difficult because of the heterogeneity of studies.

An extensive review of the literature about long-term functional results is reported in Table 4. Indeed, the literature on prospective studies of more than five years of follow-up shows satisfactory results ranging from 52 to 71% (Amundsen et al., 2000; Atlas et al., 2005; Iguchi et al., 2000; Javid and Hadar, 1998; Jonsson et al., 1998). A meta-analysis by Turner et al. (1992) conducted in 1992 demonstrated very heterogeneous results ranging from 26 to 100% of good and very good result. Some studies are based on the assessment of patient satisfaction and have also mitigated results (Atlas et al., 2005; Jonsson et al., 1998). For Jonsson et al. (1998) who studied 86 patients prospectively over a period of five years, the satisfaction term was 52%. The satisfaction was still at 70% after two years of follow-up with therefore a significant worsening between the two periods. The long-term functional outcome in our study showed comparable results with a good result in 45.9% of cases.

4.2. Predictive factors of decompressive laminectomy

The predictive factors of the functional outcome of surgical treatment were also studied in the literature.

Comorbidity was the factor most often pointed out in particular by the meta-analysis of Aalto et al. (2006). Several other studies had concluded accordingly (Airaksinen et al., 1997; Hurri et al., 1998; Jonsson et al., 1998; Katz et al., 1999; Rillardon et al., 2003). The only independent predictive factor of favorable developments that was highlighted in our multivariate analysis was the low comorbidity. Charlson score that we used for the evaluation of comorbidity assessed the associated pathologies also taking into account age.

Age was often found as a predictive factor. For Herno et al. (1995), age below 50 years was a good prognosis factor. However, Rillardon et al. (2003) and Yamashita et al. (2003) concluded that age above 65 years was correlated with good prognosis. On the other hand, the study by Shabat et al. (2011) concluded to a good result when decompressive laminectomy was offered to octogenarians. However, this study was not a comparative one and involved a small population.

Univariate analysis of our work also highlights the preoperative neurological deficit as a predictive factor for favorable development. It was reported in many series in the literature. This result means that the appearance of a neurological deficit seems to be the appropriate moment in the natural evolution of spinal stenosis to perform a surgical release.

The influence of anatomic features of the stenosis (seat, extent, significance) was also studied in the literature. Herno et al. (1995), Jonsson et al. (1998), Hurri et al. (1998), reported that the significant stenosis was a factor of a better outcome. For Katz et al. (1999) this factor had no influence. For Iguchi et al. (2000), patients affected by a multilevel stenosis had a poorer clinical outcome than those harboring a one level stenosis.

Some psychosocial factors have been particularly studied in the literature, like a pre- or postoperative professional activity (Herno et al., 1995), the feeling of good health of the patient (Aalto et al., 2006; Katz et al., 1999), the preoperative subjective difficulty for

Table 4

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of patient</th>
<th>Follow-up</th>
<th>Criteria of evaluation</th>
<th>Results at the end of follow-up</th>
<th>Predictive factors of favorable outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turner et al., 1992</td>
<td>Average: 47 (74 articles) Meta-analysis</td>
<td>Pre-op: 105 Follow-up: 86</td>
<td>5 years</td>
<td>Pain, ability to work, functional status</td>
<td>Excellent and good: 64% (26 to 100%)</td>
</tr>
<tr>
<td>Jonsson et al., 1998</td>
<td>Pre-op: 170 Follow-up: 146</td>
<td>1 at 11 years</td>
<td>Patient satisfaction</td>
<td>Excellent: 52%</td>
<td>Antero-posterior diameter &lt; 6 mm Low comorbidity Claudication and leg pain &lt; at 4 years</td>
</tr>
<tr>
<td>Javid and Hadar, 1998</td>
<td>Pre-op: 32 Follow-up: 28</td>
<td>10 years</td>
<td>Self assessment Pain Walking distance Physical activity JOA score</td>
<td>Good result: 71%</td>
<td></td>
</tr>
<tr>
<td>Amundsen et al., 2000</td>
<td>Pre-op: 150 Follow-up: 37</td>
<td>13 years</td>
<td>Function: pain, satisfaction</td>
<td>Excellent and good: 60%</td>
<td>1 level recalibrated</td>
</tr>
<tr>
<td>Atlas et al., 2005</td>
<td>Pre-op: 63 Follow-up: 56</td>
<td>8 at 10 years</td>
<td>VAS score</td>
<td>Satisfaction: 55%</td>
<td>No significant factor</td>
</tr>
<tr>
<td>Yamashita et al., 2003</td>
<td>Pre-op: 102 Follow-up: 70</td>
<td>5 years</td>
<td>Beaujon score</td>
<td>Improved Beaujon score ((P = 0.01)) Good result: 45.9%</td>
<td>Low comorbidity ((P = 0.01))</td>
</tr>
<tr>
<td>Foulongne et al., 2012</td>
<td>Pre-op: 132 Follow-up: 98</td>
<td>5 years</td>
<td>Beaujon score</td>
<td>Improved Beaujon score ((P = 0.01)) Good result: 45.9%</td>
<td>Low comorbidity ((P = 0.01))</td>
</tr>
</tbody>
</table>

Pre-op: preoperatively; mm: millimeter.
Pre-op: en préopératoire; mm: millimètre.
walking (Aalto et al., 2006), the absence of anxiety or depressive syndrome (Aalto et al., 2006; Rillardon et al., 2003; Voorhies et al., 2007), a higher income (Aalto et al., 2006), and the absence of personal injuries or claim (Voorhies et al., 2007).

4.3. Limits and interest of this study

Our study is hampered by an information bias due to an initial target established a posteriori. The retrospectively preoperative evaluation performed on patient files is another weakness of our work. The rate of loss to follow-up (31%), corresponds to the literature. In our series, the complication and reoperation rate was 14% and was comparable to other published studies, which ranged from 8 to 23% (Herno et al., 1995; Iguchi et al., 2000; Jonsson et al., 1998; Katz et al., 1999; Rillardon et al., 2003). The assessment at five years in our clinic patient with a single, independent observer has reduced bias assessment and is a specified benefit through many studies. The function evaluation was performed by the Beaujon score, which is well-known and used in several studies (Mariconda et al., 2000; Rillardon et al., 2003). The Oswestry score was often used in various studies (Airaksinen et al., 1997; Gelalis et al., 2010; Haro et al., 2008; Herno et al., 1995; Nemec et al., 2010; Thorns et al., 2011; Yasar et al., 2009). This score was originally developed to assess patients complaining of a low back pain therefore poorly suited to the evaluation of patients with predominant leg pain. Many studies evaluate outcome only with a subjective assessment provided by the patients themselves (Corneford et al., 2000; Gelalis et al., 2006; Hansraj et al., 2001; Jonsson et al., 1998; Katz et al., 1999; Rompe et al., 1999; Turner et al., 1992).

As we reported above, most published series have found an improved functional outcome in the medium and long term. Our study shows a significant improvement (P = 0.001) of the Beaujon score between the preoperative status and five years after laminectomy. This score increased from 9.3 ± 3.1 preoperatively to 14.1 ± 4.2 at five years. The main criterion used as a favorable outcome in our study was a Beaujon score increasing of at least five points, which usually corresponds to a disappearance of radicular and low back pain with intermittent persistent neurological deficits, improved perimeter of walk and the ability to carry out activities of daily living. Our criterion allows a more global perspective for patient and corresponds to a real improvement of the patient’s functional status. The identification of predictive factor of long-term function are essential to refine the indications for surgery and improve long-term functional results. In our study, the functional test results seemed to be good enough to conclude that the identified predictive factors have a certain meaning. It confirms that the Beaujon score allows a simple evaluation, fast and reliable functional status of patients who can achieve in practice. It serves primarily to establish criteria to assess the timing for the surgical management of degenerative lumbar spinal stenosis. A Beaujon score under 11 points which corresponds to the median preoperative score and to the occurrence of a neurological deficit is the best timing to undertake surgery. The presence of a low comorbidity characterized by a Charlson score of less than or equal to 3 increases the chance of getting a good result on the function in the long term.

5. Conclusion

Our study demonstrates that surgical treatment of lumbar spinal stenosis improved by 49.5% at five years. The only independent predictive factor of long-term improvement reveals that comorbidity may limit significantly the quality of the expected functional result and should be considered when choosing the therapeutic orientation. The Beaujon score appears as a useful tool in the preoperative evaluation. The outbreak of a neurological deficit and a Beaujon score below 11 during the natural evolution of the degenerative lumbar stenosis is the appropriate threshold in order to obtain optimal long-term results.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


