

# Surgical Management of Degenerative Lumbar Spinal Stenosis: Decompressive Laminectomy alone versus Decompressive Laminectomy with Lumbar Arthrodesis: A Malian Experience about 124 Cases

Oumar Coulibaly<sup>1\*</sup>, Kisito Quénum<sup>2</sup>, Mahamadou Dama<sup>1</sup>, Daouda Sissoko<sup>1</sup>, Youssouf Sogoba<sup>1</sup>, Moussa Diallo<sup>1</sup>, Mamadou Salia Diarra<sup>1</sup>, Fatogoma Sangaré<sup>3</sup>, Drissa Kanikomo<sup>1</sup>, Oumar Diallo<sup>1</sup>

<sup>1</sup>Départements de Neurochirurgie, Université de Sciences, de Techniques et de Technologies de Bamako (U.S.T.T.B), Bamako, Mali

<sup>2</sup>Département de Neurochirurgie, Université de Parakou, Parakou, Benin

<sup>3</sup>Département de Traumatologie-Orthopédique, Université de Sciences, de Techniques et de Technologies de Bamako (U.S.T.T.B), Bamako, Mali

Email: \*coulibalynch1@gmail.com

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## Abstract

**Introduction:** Degenerative Lumbar Spinal Stenosis (DLSS) is an acquired spinal disease associated with age and osteoarthritis in more than 95%. It is an osteo-disco-ligamentous conflict located on the nerves of the cauda equina. The aim of our work is to carry out a comparative study in the management of this pathology in our daily practice. **Materials and methods:** This study was a retrospective review of 124 cases of degenerative lumbar spinal stenosis treated in our department over a period of 09 years. There was 72 men and 52 women. All of our patients have undergone lumbar CT scan. The surgical decision was formally made after failure of medical treatment at least 03 months. **Results:** The sex ratio was 1.38 M / 1F. The mean age of presentation was 48.56 years with extremes ranging from 28 to 77 years. Farmers were the most affected patients with 40%, followed by housewives and civil servants with respectively 28% and 23%. The mean duration of symptoms before presentation was 15 months with extremes ranging from 06 months to 02 years. The most clinical symptoms were dominated by neurogenic claudication followed by lumbar back pain. Sixty two percent (62%) of our patients underwent lumbar arthrodesis (group 1) and thirty eight (38%) underwent simple laminectomy (group 2). We noted an overall success of 98.70% in group 1 versus 89.36% in

group 2 after one year of follow-up. Delayed wound healing, surgical site infection, postoperative fibrosis, insufficient decompression, and adjacent segment syndrome were the main complications encountered in our series. We noted 1 case of death. **Conclusion:** The degenerative narrow lumbar canal will be a public health problem in several countries, including ours. Especially due to arthritis phenomena, its management must take into account the patient's age, weight, occupation and also radiological data. Laminectomy with osteosynthesis seems to be better for us, compared to simple laminectomy.

## Keywords

Narrow Lumbar Canal, Lumbar CT, Osteosynthesis, Laminectomy

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## 1. Introduction

Lumbar spinal stenosis was described for the first time by Verbiest H. in 1954 and was divided into two main entities: congenital lumbar spinal stenosis (CLSS) and degenerative lumbar spinal stenosis (DLSS) [1]. This last one is discussed in this study. DLSS is an acquired spinal pathology related to aging, wear-and-tear, trauma and osteoarthritis in more than 95% of cases [2]-[4]. It is an osteo-disco-ligamentary conflict between the container represented by the bone and disco-ligamentary sphere; and the content represented by the roots of the cauda equina at lumbar level [1]. This conflict can lead to various symptoms ranging from a simple lumbosciatalgia or lumbocruralgia at the beginning to a true disabling neurogenic claudication with bowel and anal failure at an advanced stage. In Mali, spine surgery is very expensive and out of reach of most patients who have to pay out of their pockets. In our practice, surgical treatment of patients with severe DLSS is the most common indication for spine surgery. The aim of this study is to compare the surgical management of this spinal pathology in a tertiary health institution in Mali.

## 2. Materials and Methods

This is a retrospective study of 124 patients treated in the department of neurosurgery of "Hôpital du Mali" over a period of 09 years. There were 72 men (57.27%) and 52 women (42.73%). Only all consenting patients with obvious clinical symptoms with good clinico-radiological correlation were included in this study. The surgical decision was only formally taken after failure of well-monitored medical treatment for at least 03 months. Were excluded, all the patients who refused to be operated. All our selected patients benefited a lumbar CT scan. According to the Visual Analogue Scale (VAS), they were evaluated preoperatively and postoperatively at 1<sup>st</sup> day, 02 weeks, 03 months, 06 months and at 01 year. Data were analyzed with SPSS 20 software, entered with a MacBook pro office 2020 device and statistical analysis was done using simple T test (Student test). Test for significance was set at  $p < 0.05$ .

### 3. Results

The sex ratio was 1.38 M/1F. The average age of our patients was 48.56 years with extremes ranging from 28 to 77 years. The most affected age group was between 40 - 70 years. Farmers were most affected, followed by housewives and civil servants. Most of our patients had had intense physical activities in the past. The following table summarizes the main epidemio-clinical characteristics of our patients (**Table 1**). All of our patients had normal weight for height. The notion of carrying heavy loads was found as a triggering factor for pain in fourteen cases. The mean duration of symptoms before admission was 15 months with extremes

**Table 1.** Main characteristics of our patients.

Characteristics	Number	Frequency
<b>Sex distribution:</b>		
- Male	63	57.27
- Female	47	42.73
<b>Age distribution:</b>		
- 50	1	0.91
- 71	8	7.27
- 91	33	30
- 111	40	36.36
- 131	21	19.09
- 151	7	6.36
<b>Occupation:</b>		
- Farmers	47	42.72
- Housewives	29	26.36
- Teachers	13	11.81
- Military	10	9.09
- Tradespeople	7	6.36
- Tailors	4	3.63
<b>Clinical presentation:</b>		
- Neurogenic claudication	101	91.81
- Lombosciatalgia	86	78.18
- Lumbar back pain	74	67.26
- Paresthésia	70	63.63
- motor deficit with amyotrophy	62	56.36
- Urinary signs	17	15.45
- Cauda equina syndrome	6	5.45

ranging from 06 months to 02 years. The clinical symptomatology was dominated by intermittent neurogenic claudication with reduced walking distance in 92.74% of cases, followed by lumboscialgia and lumbar back pain in respectively 78.22% and 68.55%. Paresthetic disorders such as numbness and/or tingling were noted in 92 patients (74.19%). A motor deficit with amyotrophy was found in more than half of our patients (60.48%). Cauda equina syndrome was only found in 07 cases (**Table 1**). Before surgery, all our patients had a Visual Analogue Scale (VAS score) between 7 - 10 (**Table 2**). Frontal and profile lumbar radiography was only done in 11 cases and shown end-plate sclerosis, osteophytes and narrowing of the disc space in just 06 cases.

**Table 2.** Postoperative improvement profile in our two groups according to the VAS.

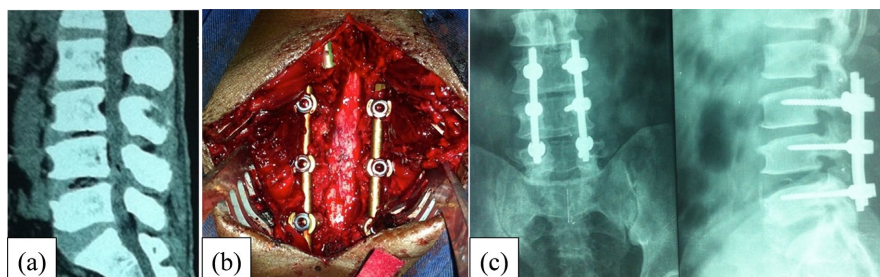
	Preoperative	15 days	03 months	06 months	01 year
<b>Group I</b>	100%	83.11%	80.51%	94.81%	97.40%
	77 cases	64	62	73	75
VAS I	7 - 10	5 - 6	4 - 3	3 - 2	1 - 2
average	8.5	5.5	3.5	2.5	1.5
<b>Group II</b>	100%	78.72%	72.34%	85.11%	89.36%
	47 cases	37	34	40	42
VAS II	7 - 10	4 - 5	4 - 5	4 - 3	3 - 2
average	8.5	4.5	3.5	3.5	2.5

The lumbosacral CT scan was performed in all our patients and facilitated to specify the seat and the extent of of facet joint arthritis and foraminal compromise by osteophytes. Myeloscanner and lumbar MRI were done respectively in 08 and 05 patients and provided the same radiological information as the scanner, but slightly more contributory than this one. On our explorations, spinal levels L4/L5 and L3/L4 were the most affected followed by L5/S1 and L2/L3. We divided our patients in 2 groups, all symptomatic patients with radiological confirmation. In these 02 groups, patients were enrolled based on their clinical presentation, occupation, age and of course the location and the character of the stenosis.

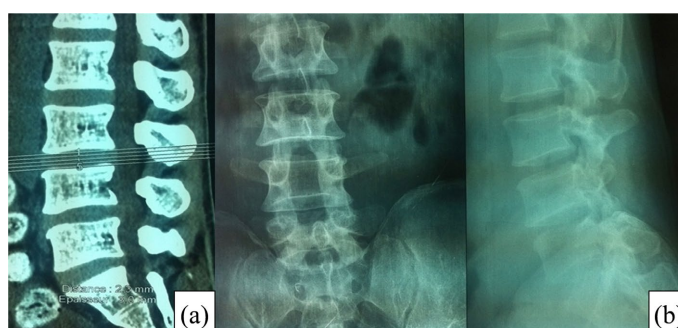
In the first group (group I), seventy-seven patients (77 cases) were operated. In supine position and on general anesthesia, a 4-7 cm posterior midline skin incision was made and the paraspinal muscles were retracted using a self-retaining retractor. Under image-intensifier, the pedicle screws were inserted first followed by laminectomies with or without dissectomy. This lumbar arthrodesis with laminectomy had been widely requested in young patients with high socio-economic activity. In this group, this indication was performed in all our patients with a narrow lumbar canal with spinal static abnormalities (straightness or kyphosis) and/or more than two levels of advanced disc disease, generally with a disc void (**Figure 1**).

In the second group (group II), forty-seven patients (47 cases) underwent simple decompressive laminectomy with or without dissectomy. This protocol had

been widely done in elders with spinal lumbar stenosis with or without normal morphology (**Figure 2**).



**Figure 1.** (a) Lumbar CT scan showing a DLSS L3, L4, L5 with disc void on L3/L4 et L4/L5 in a 44-year-old young farmer. (b) Operative view with laminectomy and lumbar arthrodesis. (c) Post-operative lumbar control X-ray (Face and Profile).



**Figure 2.** (a) Lumbar CT scan showing a DLSS causing by a L4/L5 disc herniation in a 53-year-old young trader. (b) Post-operative lumbar x-ray (Face and Profile)

However, the narrowness of spinal stenosis was also confirmed intraoperatively in all our patients. In the group I, 02 patients worsened secondarily but with a significant improvement after 06 months of physiotherapy. Three patients in group II remained stationary with persistence of lumbosciatalgia, and 02 patients worsened and required secondary osteosynthesis during the same period. All our patients had a VAS  $\leq 5$  after 03 months with a very clear improvement after one year follow-up with an overall success of 97.40% in group I versus 89.36% in group II ( $p < 0.05$ ). Unfortunately, we lost 01 patient in group I during operation, death probably related to blood crisis disorders. The following table summarizes the evolutionary profile of these 02 groups studied in our series (**Table 2**). However, some minor complications had been found in our series in various proportions and listed in the last table (**Table 3**). The wound infection (wall and deep infections) was the first complication in our study, followed by delayed healing and postoperative fibrosis in respectively 11.29%, 10.48% and 3.23%.

#### 4. Discussion

DLSS is a pathological entity well known by spinal surgeons, but their surgical management remains a subject of debate. Admittedly, it is seen mainly in the elderly, but this condition tends to be found in young and generally those with

**Table 3.** Postoperative complications encountered in our study.

Complications	Laminectomy	Arthrodesis
Delayed healing	04	09
Wall infection	06	06
Postoperative fibrosis	02	02
Insufficient decompression	03	01
Adjacent segment syndrome	02	01
Deep infection	02	0

intense socio-economic activities [5] [6]. Its prevalence had been 19% in the series of Muthuuri J.M. *et al.* [6] in Kenya, 37.7% and 67% respectively in the series of Kabré A. *et al.* and Varlet G. *et al.* in Burkina Faso and Ivory coast [7] [8]. These data were 12.73% in our series. The average age of our patients was 48.56 years with extremes ranging from 28 to 77 years. The age of onset of this pathology is around 60 years old with extremes ranging from 16-82 years in the literature [9] [10]-[12]. The males remained the most affected patients in the majority of the studied series [6] [13] [14]. This predominancy was found in our series and could be explained by the role that men play in our society in Mali. In addition, obesity, tobacco consumption and intense physical activity using the spine remain the predisposing factors associated with DLSS in the literature [3] [6] [15]. However, only this last predisposing factor was found in all our patients. However, the diagnosis remains clinical and dominated by neurogenic intermittent claudication with reduced walking distance at a late stage [2] [15] [16]. This rate would be around 91.81% in our series versus 84.6% in the series of Oniankitan *et al.* [17], 95% in the series of Kanikomo *et al.* [9] and 100% in the series of Ige O.O *et al.* [13]. This high percentage was according to the relatively long treatment time in our different countries. This would also explain the high rate of the mean pain threshold, which was around 8.5 in our series according to the VAS. These data are in line with those found by Muoghalu O.N. *et al.* [10] and Ige O.O. *et al.* [13]. On the other hand, the cauda equina syndrome is a symptom of rare revelation and would be around 5.45% in our study against 12% in the series of Hall *et al.* [16]. A motor deficit with amyotrophy completed our clinical data in approximately 56.36%. We are convinced that lumbar MRI remains the gold standard exploration in DLSS, but given the low socio-economic level of our patients and the lack of medical insurance, the majority of our indications were based on lumbar CT scan, of course according to clinical symptomatology. This attitude had been supported by other authors [5] [9] [18]. The management of DLSS involves two main options: a medical therapy (including medication, physical therapy, Transcutaneous Electrical Nerve Stimulation and Epidural Spinal Injections) and a surgical component (including open, minimally invasive and endoscope procedures) [5]. This last part, which is the subject of this study, should only be designed after failure of well-conducted medical treatment at least 3 months. This attitude was claimed by oth-

ers authors [6] [13]. Several surgical techniques have been described in the literature, ranging from simple recalibration in the event of limited ductal stenosis, to laminarthrectomy in the event of intraductal osteophytosis, or even spinal arthrodesis via the posterior approach in the event of associated compressive mechanisms [18]-[20]. This surgical treatment of DLSS must take into account the age of the patient, his professional activity, the morphology of the lumbar spine and the extent of the stenosis at the time of diagnosis [21]-[23]. In our study, decompressive laminarthrectomy alone was performed in 47 patients and decompressive laminarthrectomy with posterior arthrodesis in 77 patients. This arthrodesis by posterior approach seems to be justified for us especially in young and professionally active patients presenting a narrow lumbar canal stenosis with generally a potential spinal deformity (more than two levels of discal void with or without spinal straightness). This arthrodesis technique via the posterior approach has been encouraged by other authors, judging its superiority compared to decompressive laminarthrectomy alone [24]-[28]. However, the young age of patients, active smoking, obesity and depression can be factors of poor prognosis that can influence the success of this surgery [3] [6] [29]-[33]. Weight loss, smoking cessation and the reduction or even cessation of intense professional activities were strongly advised before surgery in our series. These same data had been seen in others studies worldwide.

## 5. Conclusion

The Degenerative Lumbar Spinal Stenosis (DLSS) will constitute a public health problem in several countries, including specially ours. Mainly due to osteoarthritis phenomena, its management must take into account the patient's age, weight, professional activities, without forgetting neuroradiological data. Arthrodesis via the posterior approach seems to us to be better indicated compared to simple laminectomy, especially in active patients.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

- [1] Verbiest, H. (1954) A Radicular Syndrome from Developmental Narrowing of the Lumbar Vertebral Canal. *The Journal of Bone and Joint Surgery, British Volume*, **36**, 230-237. <https://doi.org/10.1302/0301-620x.36b2.230>
- [2] Katz, J.N. and Harris, M.B. (2008) Clinical Practice: Lumbar Spinal Stenosis. *New England Journal of Medicine*, **358**, 818-825. <https://doi.org/10.1056/nejmcp0708097>
- [3] Rubin, D.I. (2007) Epidemiology and Risk Factors for Spine Pain. *Neurologic Clinics*, **25**, 353-371. <https://doi.org/10.1016/j.ncl.2007.01.004>
- [4] Wu, L., Munakomi, S. and Cruz, R. (2025) Lumbar Spinal Stenosis. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK531493/>
- [5] Bagley, C., MacAllister, M., Dosselman, L., Moreno, J., Aoun, S.G. and El Ahmadi, T.Y. (2019) Current Concepts and Recent Advances in Understanding and Managing

- Lumbar Spine Stenosis. *F1000 Research*, **8**, Article 137.  
<https://doi.org/10.12688/f1000research.16082.1>
- [6] Muthuuri, J.M., Some, E.S. and Chege, P. (2019) Prevalence of Developmental Lumbar Spinal Canal Stenosis among Adult Population in the Coastal Region of Kenya. *East African Orthopaedic Journal*, **13**, 26-33.
- [7] Kabré, A., Ba, M.C., Cissé, R., *et al.* (2003) Le canal lombaire étroit à Ouagadougou: Aspects étiologiques, cliniques et pronostiques sur une étude de 80 cas. *Dakar medical*, **48**, 138-141.
- [8] Varlet, G., Ba Zeze, V., Boni, N., *et al.* (1996) Les canaux lombaires étroits à propos d'une série de 60 cas opérés au CHU d'Abidjan. *Annales de l'université d'Abidjan médecine*, **36**, 101-110.
- [9] Kanikomo, D., Sogoba, Y., Dama, M., Traoré, S.N., Coulibaly, O., Diarra, M.S., *et al.* (2015) Aspect Clinique et Thérapeutique du Canal Lombaire: A Propos de 24 cas enregistrés au CHU Gabriel Touré de Bamako. *Mali Medical*, **30**, 24-28.
- [10] Muoghalu, O.N., Nwadinigwe, C.U., Iyidobi, E.C., Duru, N.N., Anyaehie, U.E. and Okwesili, I.C. (2018) Early Functional Outcome of Posterior Spinal Decompression for Lumbar Spinal Stenosis at a Tertiary Health Institution, South East Nigeria. *Journal of Biosciences and Medicines*, **6**, 1-14. <https://doi.org/10.4236/jbm.2018.67001>
- [11] Ba, M.C., Badiane, S.B., Sakho, Y., Kabré, A., Badane, M., Gueye, E.M., Baly, A. and Gueye, M. (1994) Le canal lombaire étroit: À propos de 64 cas colligés à la clinique neurochirurgicale du CHU de Dakar. *Dakar Médical*, **39**, 199-202.
- [12] Ishimoto, Y., Yoshimura, N., Muraki, S., Yamada, H., Nagata, K., Hashizume, H., *et al.* (2012) Prevalence of Symptomatic Lumbar Spinal Stenosis and Its Association with Physical Performance in a Population-Based Cohort in Japan: The Wakayama Spine Study. *Osteoarthritis and Cartilage*, **20**, 1103-1108.  
<https://doi.org/10.1016/j.joca.2012.06.018>
- [13] Ige, O., Lawal, O., Olufemi, T., Ojodu, I., Igbinoba, B. and Alao, S. (2019) Outcomes of Surgical Management of Severe Lumbar Spinal Canal Stenosis. *Nigerian Journal of Orthopaedics and Trauma*, **18**, 18-22. [https://doi.org/10.4103/njot.njot\\_6\\_19](https://doi.org/10.4103/njot.njot_6_19)
- [14] Madkouri, R., Brauge, D., Vidon-Buthion, A., Fahed, E., Mourier, K., Beaurain, J., *et al.* (2018) Improvement in Sagittal Balance after Decompression Surgery without Fusion in Patients with Degenerative Lumbar Stenosis: Clinical and Radiographic Results at 1 Year. *World Neurosurgery*, **114**, e417-e424.  
<https://doi.org/10.1016/j.wneu.2018.03.002>
- [15] Holden, F.O., Mofou, B., Ginette, P.A., *et al.* (2014) La sténose du canal lombaire: Résultats chirurgicaux et fonctionnels dans une unité de Neurochirurgie au Bénin. *African Journal of Neurological Sciences*, **33**, 17-25.
- [16] Hall, S., Bartleson, J.D., Onofrio, B.M., Baker, H.L., Okazaki, H. and O'Duffy, J.D. (1985) Lumbar Spinal Stenosis. Clinical Features, Diagnostic Procedures, and Results of Surgical Treatment in 68 Patients. *Annals of Internal Medicine*, **103**, 271-275.  
<https://doi.org/10.7326/0003-4819-103-2-271>
- [17] Oniankitan, O., Magnan, A., Fianyo, E., *et al.* (2007) Le canal lombaire rétréci en consultation rhumatologique à Lomé (Togo). *Médecine tropicale*, **67**, 263-266.
- [18] Athiviraham, A. and Yen, D. (2007) Is Spinal Stenosis Better Treated Surgically or Nonsurgically? *Clinical Orthopaedics & Related Research*, **458**, 90-93.  
<https://doi.org/10.1097/blo.0b013e31803799a9>
- [19] Steib, J.P., Averous, C.H., Brinckert, D. and Lang, G. (1996) Le recalibrage dans le traitement du canal lombaire étroit. *European Journal of Orthopaedic Surgery &*

- Traumatology*, **6**, 129-134. <https://doi.org/10.1007/bf00568331>
- [20] Charles, Y.P. and Steib, J.P. (2017) Diagnostic et traitement du canal lombaire étroit. *Médecine thérapeutique*, **23**, 136-144
- [21] Weber, C., Giannadakis, C., Rao, V., Jakola, A.S., Nerland, U., Nygaard, Ø.P., *et al.* (2016) Is There an Association between Radiological Severity of Lumbar Spinal Stenosis and Disability, Pain, or Surgical Outcome? *Spine*, **41**, E78-E83. <https://doi.org/10.1097/brs.0000000000001166>
- [22] Andersen, T., Christensen, F.B., Niedermann, B., Helmig, P., Høy, K., Hansen, E.S., *et al.* (2009) Impact of Instrumentation in Lumbar Spinal Fusion in Elderly Patients. *Acta Orthopaedica*, **80**, 445-450. <https://doi.org/10.3109/17453670903170505>
- [23] Gu, Y., Chen, L., Yang, H.L., Chen, X.Q., Dong, R.B., Han, G.S., *et al.* (2009) Efficacy of Surgery and Type of Fusion in Patients with Degenerative Lumbar Spinal Stenosis. *Journal of Clinical Neuroscience*, **16**, 1291-1295. <https://doi.org/10.1016/j.jocn.2009.01.007>
- [24] Aalto, T.J., Malmivaara, A., Kovacs, F., Herno, A., Alen, M., Salmi, L., *et al.* (2006) Preoperative Predictors for Postoperative Clinical Outcome in Lumbar Spinal Stenosis: Systematic Review. *Spine*, **31**, E648-E663. <https://doi.org/10.1097/01.brs.0000231727.88477.da>
- [25] Lønne, G., Fritzell, P., Hägg, O., Nordvall, D., Gerdhem, P., Lagerbäck, T., *et al.* (2019) Lumbar Spinal Stenosis: Comparison of Surgical Practice Variation and Clinical Outcome in Three National Spine Registries. *The Spine Journal*, **19**, 41-49. <https://doi.org/10.1016/j.spinee.2018.05.028>
- [26] Epstein, N.E. (2008) An Analysis of Noninstrumented Posterolateral Lumbar Fusions Performed in Predominantly Geriatric Patients Using Lamina Autograft and Beta Tricalcium Phosphate. *The Spine Journal*, **8**, 882-887. <https://doi.org/10.1016/j.spinee.2007.11.005>
- [27] Resnick, D.K., Watters, W.C., Mummaneni, P.V., Dailey, A.T., Choudhri, T.F., Eck, J.C., *et al.* (2014) Guideline Update for the Performance of Fusion Procedures for Degenerative Disease of the Lumbar Spine. Part 10: Lumbar Fusion for Stenosis without Spondylolisthesis. *Journal of Neurosurgery: Spine*, **21**, 62-66. <https://doi.org/10.3171/2014.4.spine14275>
- [28] Groff, M.W., Dailey, A.T., Ghogawala, Z., Resnick, D.K., Watters, W.C., Mummaneni, P.V., *et al.* (2014) Guideline Update for the Performance of Fusion Procedures for Degenerative Disease of the Lumbar Spine. Part 12: Pedicle Screw Fixation as an Adjunct to Posterolateral Fusion. *Journal of Neurosurgery: Spine*, **21**, 75-78. <https://doi.org/10.3171/2014.4.spine14277>
- [29] Ghogawala, Z., Dziura, J., Butler, W.E., Dai, F., Terrin, N., Magge, S.N., *et al.* (2016) Laminectomy Plus Fusion versus Laminectomy Alone for Lumbar Spondylolisthesis. *New England Journal of Medicine*, **374**, 1424-1434. <https://doi.org/10.1056/nejmoa1508788>
- [30] McKillop, A.B., Carroll, L.J. and Battié, M.C. (2014) Depression as a Prognostic Factor of Lumbar Spinal Stenosis: A Systematic Review. *The Spine Journal*, **14**, 837-846. <https://doi.org/10.1016/j.spinee.2013.09.052>
- [31] Sandén, B., Försth, P. and Michaëlsson, K. (2011) Smokers Show Less Improvement Than Nonsmokers Two Years after Surgery for Lumbar Spinal Stenosis: A Study of 4555 Patients from the Swedish Spine Register. *Spine*, **36**, 1059-1064.
- [32] Giannadakis, C., Nerland, U.S., Solheim, O., Jakola, A.S., Gulati, M., Weber, C., *et al.* (2015) Does Obesity Affect Outcomes after Decompressive Surgery for Lumbar Spi-

nal Stenosis? A Multicenter, Observational, Registry-Based Study. *World Neurosurgery*, **84**, 1227-1234. <https://doi.org/10.1016/j.wneu.2015.06.020>

- [33] Nerland, U.S., Jakola, A.S., Giannadakis, C., Solheim, O., Weber, C., Nygaard, Ø.P., *et al.* (2015) The Risk of Getting Worse: Predictors of Deterioration after Decompressive Surgery for Lumbar Spinal Stenosis: A Multicenter Observational Study. *World Neurosurgery*, **84**, 1095-1102. <https://doi.org/10.1016/j.wneu.2015.05.055>