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ORIGINAL PAPER

Is it safe to perform lumbar spine surgery on patients over eighty five?

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Abstract
Purpose The purpose of this study was to evaluate the safety and tolerance of lumbar spine surgery in patients over 85.
Materials and methods Patients over 85 years of age with LSS who underwent decompression surgery with or without fusion between February 2011 and July 2014 were included. Comorbidities, autonomy (Activities of Daily Life and Braden scales), surgical parameters and complications (Clavien-Dindo classification) were collected. A telephone survey was performed to assess survival and patients' satisfaction at last follow-up.
Results Mean follow-up was 27.4 ± 7.6 months (range, 18–65). Mean age was 87.5 ± 2.7 years (range, 85–97). Mean ADLs and Braden scores were, respectively, 4.3 ± 1.2 and 20.2 ± 1.4. Fifteen patients had associated spondylolisthesis. Nineteen minor complications (grade I and II, 38.7%), five moderate complications (grade III, 10.2%) and six major complications (grade IV and V, 12.2%) occurred. The perioperative mortality rate was 0.02%. At last follow-up, 41 patients were very satisfied (83.7%), five patients were satisfied (10.2%) and three patients were not satisfied (6.1%). Fusion did not affect the incidence of complications ($p = 0.3$) nor the average number of complications per patient ($p = 0.2$).
Conclusion Advanced age should not be a contraindication to lumbar spine surgery provided careful preoperative selection is performed. This study reported a high satisfaction rate and a low mortality rate at the price of a high number of complications, most of which being minor.

Keywords Lumbar spinal stenosis · Morbidity · Satisfaction · Nutrition · Frailty · Risk factors

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Introduction

Life expectancy in industrialized countries has been continuously increasing with a higher demand from patients in terms of quality of life and functional abilities. According to the latest World Health Organization (WHO) data published in 2015 [1], life expectancy in France was 79.4 years for males and 85.4 years for females.

Lumbar spinal stenosis (LSS) and spondylosis represent significant factors of morbidity among the elderly [2]. Even though surgical decompression (laminectomy or spinal fenestration) is an effective treatment, numerous patients are not considered good candidates for surgery due to advanced age or comorbidities. Surgeons are often reluctant to operate on patients aged 85 and older fearing peri-operative and post-operative complications or death. Indeed, spinal surgery for LSS is most often not mandatory, most cases being elective. Furthermore, increasing pain and difficulty ambulating in geriatric patients may lead to a dangerous functional deterioration. On the other hand, successful surgical outcome can provide better quality of life to the elderly. Continuous improvements in surgical techniques and increased expectations regarding physical function have resulted in a rise of surgical procedures for LSS, which is the most frequent indication for spinal surgery in the elderly.

Most studies assessing the impact of age on surgical outcome included patients over 80 and showed a good clinical outcome at the price of higher rates of complications and mortality [3–6]. However, further analysis of these series shows that mortality increases dramatically after an 80–85 years old threshold. To our knowledge, no study has previously included patients exclusively over 85. The aim of this study was to evaluate the safety and tolerance of lumbar spine surgery (decompression, fusion, or both) in patients aged 85 and older, in particular relative to the presence of comorbidities.

Materials and methods

Study design and population

A retrospective study included all consecutive patients over 85 operated for LSS between February 2011 and July 2014 in a single centre. The present study was approved by the local Institutional Review Board. The inclusion criteria were: (1) patients operated for LSS, (2) aged 85 and older, (3) primary or revision surgery, and (4) neurogenic claudication or radiculopathy. Patients with active infection, neoplasm, exclusive lower back pain or bedridden patients were excluded from the study.

Evaluation criteria

The collected demographic data were: age, gender, body mass index (BMI), and ASA score.

Potential risk factors of morbidity or mortality were also analyzed [3–6] including:

- Cardiovascular risk factors
- Chronic medical conditions
- Treatment: anticoagulant therapy, antiplatelet drugs
- Pre-operative nutritional status gross estimation: total serum protein, BMI
- Pre-operative and postoperative leg pain assessment using the visual analogue scale (VAS)
- Pre-operative autonomy: the Braden scale and Activities of Daily Living Scale (ADLs) [7, 8]. The Braden score was used to evaluate the risk of pressure sores: no risk (19–23), mild risk (15–18), moderate risk (13–14), high risk (10–12), very high risk (9 or less). The ADLs was used with six items: bathing, dressing, toileting, transferring, eating and use of incontinence materials. Each item was scored 1 (independent), 0.5 (partially dependent) or 0 (dependent). The primary outcome was post-operative survival. The occurrence of medical and surgical complications was also analyzed. They were rated according to a modified Clavien-Dindo classification [9] (Table 1). Complications graded I and II were summarized as minor complications; complications graded III were summarized as moderate complications; complications graded IV and V were summarized as major complications.

A telephone survey was performed to assess survival and patient satisfaction (not satisfied, satisfied, very satisfied) at least three months after surgery.

Statistical analysis

Correlations were analyzed with Spearman's rank test, proportions with chi-square tests and differences with Mann-Whitney tests. Risk of complication was analyzed in relation to the evaluation criteria, and a risk index was developed by combining the significant criteria in a multivariable model. All analyses were performed in Matlab 2015b; significance was set at $p < 0.05$.

Results

Population

Forty-nine patients were included: 30 females (61%) and 19 males (39%). Mean age was 87.5 ± 2.7 years at surgery (range, 85–97). The age distribution was as follows: 85–89 (37 patients; 75.5%) and 90–94 (12 patients; 24.5%). Only one patient was over 95 (Fig. 1). Seven patients (14.2%) had revision surgery. All patients had elective surgery. The main indication for surgery was LSS with or without spondylolisthesis in 45 patients (92%). Only four patients (8%) had isolated foraminal stenosis with severe radiculopathy. Pre-operative VAS was 6.0 ± 1.5.

Pre-operative health status and comorbidities

Mean ejection fraction was 68.2 ± 6.1%. The ASA distribution was: 33 ASA II and 16 ASA III. Mean BMI was 25.4 ± 3.5 kg/m^2 (range, 20.2–36.2). The main comorbidities were hypertension (65.3%), antiplatelet drug use (34.7%), diabetes (16.3%), atrial fibrillation (14.3%), peripheral arterial occlusive disease (10.2%), chronic cognitive dysfunction (12.2%) and chronic renal failure (10.2%). Patient comorbidities are reported in Table 2.

Pre-operative autonomy and nutritional status

Mean preoperative total serum protein level was 59.6 g/dl ± 6.7 g/dl (range, 48–74). Mean ADLs score was 4.3 ± 1.2 (range, 1–6). Mean Braden score was 20.2 ± 1.4 (range, 17–23).

Table 1 Classification of complications adapted from Dindo et al. [9]

Grade	Definition
I	Any deviation from the normal post-operative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included
III	Requiring surgical, endoscopic, or radiological intervention
IV	Life-threatening complication requiring IC/ICU management
V	Death of a patient

Operative data

All patients had decompressive surgery. There were 25 cases of decompression and fusion and 24 cases of decompression without fusion. The mean number of operated levels was 1.9 ± 0.9 (range, 1–4): 17 patients (34.6%) operated on one level, 22 patients (45%) on two levels, six patients (12.2%) on three levels and four patients (8.2%) on four levels. The average estimated blood loss was 397.2 ± 320.6 mL (range, 100-1500 mL). Ten patients (20.4%) had a peri-operative allogeneic blood transfusion. Mean operative time was 59 ± 23.4 minutes (range, 24–130). The mean post-operative length of stay was 7.5 ± 3.8 days (range, 3–21 days). Post-operative leg pain VAS before discharge was 1.1 ± 1.3 (range, 0–3). Thirty-one patients (63.2%) were discharged to a rehabilitation facility and 18 patients (36.7%) were discharged home.

Peri-operative complications

The total complication rate was 61.2%: 10 surgical complications (20.4%) and 20 medical complications (40.8%). Fusion did not affect the incidence of complications ($p = 0.3$) nor the average number of complications per patient ($p = 0.2$).

The frequency and grading of surgical and medical complications are reported in Table 3.

Last follow-up

Mean follow-up was 27.4 ± 7.6 months (range, 18–65). Following the telephone survey, all patients responded except one who died of a stroke 2.5 years post-operatively at 99 years old (apparently unrelated to the surgery). Forty-one patients were very satisfied (83.7%), five patients were satisfied (10.2%) and three patients were not satisfied (6.1%).

Relationships between pre-operative clinical status and post-operative outcome

Patient satisfaction was not correlated with age, sex, BMI, pre-operative autonomy, or comorbidities. Patients with a history of atrial fibrillation ($n = 7$) had significantly increased need of peri-operative transfusion than other patients (1 ± 1.5 vs 0.35 ± 0.9, $p = 0.0005$). Atrial fibrillation, peripheral arterial occlusive disease and chronic obstructive pulmonary disease and chronic cognitive dysfunction were correlated with an increased total number of complications ($p < 0.05$).

Patients with a Braden score lower than 20 ($n = 29$) had a higher number of complications than patients with a score higher than 20 ($n = 12$); the difference was significant ($p = 0.002$). Negative correlations were observed between the number of peri-operative complications and both the nutritional state (measured as preoperative serum total protein levels, Spearman's rho = −0.4, $p = 0.007$) and Braden scores (rho = 0.4, $p = 0.007$).

A "risk index" was then defined as a linear combination of these two parameters as follows:

risk index = 8.6–6.0 * Braden scale / 23–3.8 * total protein / 82

Patients with a low index (< 0.6, $n = 13$) had no peri-operative complications, but one patient needed a peri-operative transfusion. Seventeen patients had an index higher than 0.6; 60% of those patients ($n = 10$) had one or more peri-operative complications, suggesting that an index higher than 0.6 is associated with a higher risk of complication, with a relative risk of 7.2.

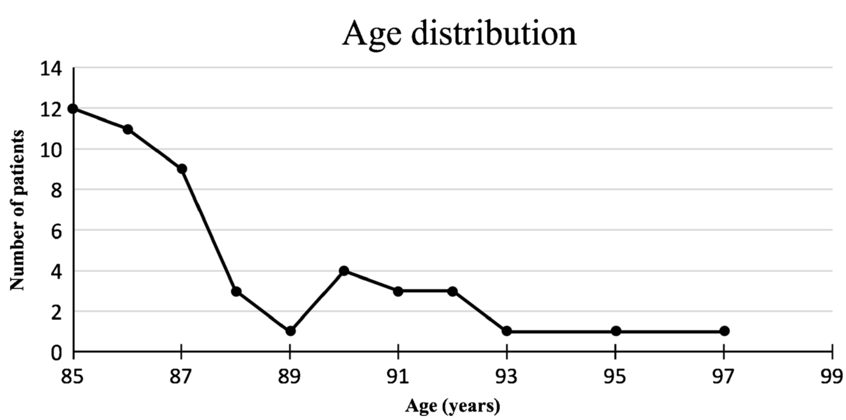

Fig. 1 Age distribution of the patient cohort. Each dot indicates the number of patients of a given age

Table 2 Patient comorbidities

Comorbidities	Frequency
Hypertension	32 (65.3%)
Antiplatelet drug use	17 (34.7%)
Atrial fibrillation	7 (14.2%)
Cognitive dysfunction	6 (12.2%)
Chronic renal failure	5 (10.2%)
Diabetes	5 (10.2%)
Peripheral arterial occlusive disease	5 (10.2%)
Myocardial infarction	4 (8.2%)
Depression	4 (8.2%)
DVT/PE	4 (8.2%)
COPD	4 (8.2%)
Sleep apnea	4 (8.2%)
Anticoagulation therapy	3 (6.1%)
Stroke	3 (6.1%)
Angina	2 (4.1%)
Hypertrophic cardiomyopathy	2 (4.1%)
Smoker	2 (4.1%)
Asthma	1 (2.0%)

Discussion

Aging populations and lumbar spine surgery

Life expectancy in industrialized countries has risen continuously since the industrial revolution. However, total life expectancy has not grown continuously with healthy life years.

Table 3 Complications: frequency and grading according to Dindo et al. [9]

Grade	Frequency	Complication	Procedures required
Surgical complications			
I	5	Incidental durotomy	None
III	2	Wound infection	Surgical revision
III	2	Post-operative spinal epidural hematoma	Surgical revision
III	1	Implant failure	Surgical revision
Medical complications			
II	10	Anaemia	Allogeneic blood transfusion
II	2	Urinary tract infection	Antibiotics
II	1	Deep venous thrombosis	Anticoagulation
II	1	Aspiration pneumonia	Antibiotics
IV	3	Severe confusion with agitation	Medication
IV	1	Acute decompensated heart failure	Diuretics
IV	1	Acute respiratory failure	Intubation
V	1	Aspiration pneumonia	–

An increase in surgical procedures performed on patients aged 85 and older was reported in the early 1990s [2]. Indeed, healthy aging, well-being and quality of life have now become issues in aging societies. These considerations raise concerns among healthcare providers, patients and their families over the prediction of post-operative morbidity, mortality and surgical outcome. Elder patients, some of which are institutionalized, and their families may be reluctant to seek medical help fearing spine surgery. Moreover, primary care physicians may not request orthopaedic referrals and favour conservative options. In addition, spinal surgeons' reputation and their quality indexes may be affected by poor outcome following surgery on elder patients.

85 years old: a morbidity and mortality threshold

The morbidity and mortality issue in the elderly undergoing lumbar spine surgery was first addressed in two studies using Medicare databases [10]: the 80–85 years old group was then first identified as a threshold of a dramatic increase in morbidity and mortality [2]. The oldest age group in most published clinical series was 80–85. According to Nanjo et al. [5], data concerning patients over 85 remain rare. This five-year gap overlaps patients' life expectancy at birth in France. The age distribution of the general population over 85 resembles an inverse exponential curve. Life expectancy in France at 85 is now 8.8 years for females and 6.9 years for males [11]. In this regard, the 85+ population may be called "survivors". There were only two smokers out of 49 patients compared with 31.1% for males and 25.8% for females nationwide [1]. Moreover, the average BMI was 25.4 kg/m^2, which lies within the range of that age group. Regarding function, the ADLs score averaged 4.3/6 and reflected a low dependency status, compared with the 20% rate of severe dependency in patients over 85 in France [12].

Complication rates

This study represents the largest series of patients exclusively over 85 undergoing spinal surgery. Our surgical and medical complication rates were, respectively, 20.4% and 40.8%, most of which were minor (63.3 overall). These figures were in the range of the data from the literature in 80–85 year olds (10–60%), suggesting that advanced age did not dramatically increase the incidence of complications [3–6, 13–15]. Further analysis reveals that the rate of incidental durotomy was also comparable to other cohorts: 10.2% in this study against 6.02% reported by Buck et al. for patients older than 73 [16]. Degenerative changes such as spinal canal narrowing, ligamentum flavum thickening and osteophyte formation increase the risk of incidental durotomy in the elderly. Several factors may explain this low mortality rate: low preoperative ASA score, short operative time, low number of fused levels, low number of peri-operative transfusions. Puvanesajarah et al. observed a 45% increase in the rates of all major medical complications in patients aged 80 and older [17]. Nanjo et al. [5] reported that almost 85% of patients in their oldest group were 80–84 years old. Similarly with Rihn et al., the risks of decompression surgery were comparable between patients aged 80–84 and those under 80. In contrast, Li et al. reported that patients over 85 had more comorbidities and post-operative complications following decompression surgery than younger groups [13].

Risk factors of post-operative complications

Raffo et al. correlated pre-operative or operative factors and complications [4]. Twenty patients over 80 were retrospectively included. They showed that comorbidities may predict major complications. In this study, patients had good autonomy (ADLs was 4.3 ± 1.2 and the Braden Score was 20.2 ± 1.4) and the ASA score was most often II (33 patients, 67.3%). Despite advanced patient age, the complication rate remained in the range found in geriatric literature. This suggests that careful pre-operative selection may compensate for the pejorative post-operative prognosis of advanced age.

Patient satisfaction

Gepstein et al. [18] described a retrospective cohort of 367 patients over 65 and concluded that pre-operative expectations in the elderly reasonably predicted postoperative satisfaction. Interestingly, the authors reported that even advanced age positively related to patients' expectations and satisfaction. However, this cohort comprised 9% patients over 85 with unknown specific satisfaction rates. Similarly, a high satisfaction rate was found in this study: the majority of patients were very satisfied (83.7%), five patients were satisfied (10.2%) and three patients were not satisfied (6.1%).

Safety of spinal fusion

The clinical benefit of spinal fusion in terms of quality of life [19], pain and disability is usually substantial and most authors advise using instrumentation whenever needed, independently of patients' age [20, 21]. Decompression, whether it was performed with or without fusion, was also shown to be cost-effective in the elderly [22]. However, several authors reported that fusion in the elderly was associated with more postoperative complications compared with younger groups or decompression-alone groups [20, 23, 24]. This main concern was part of the rationale behind the development of minimally invasive techniques. Yet in the present study, no difference was observed between decompression alone versus decompression with fusion.

Benefit–risk balance

Nanjo et al. retrospectively reviewed 702 patients with decompressive lumbar spine surgery and found that the benefits and risks of decompression surgery were similar between patients over 80 and those under 80. Yet only 1.5% of this cohort was over 85 [5]. Balabaud et al. observed a significant morbidity increase following lumbar spine surgery was caused by high blood loss, increased operative time, use of instrumentation, history of previous surgery and incidental durotomy [6]. He advised that instrumented fusion should be limited and more cautiously decided in older patients. Pérez-Prieto et al. concluded that age itself should not be a contraindication given the expected postoperative increase in quality of life, disability or satisfaction. Quigley et al. showed the safety of lumbar spine surgery in patients over 75 [3]. A safe attitude with regard to patients over 85 is to carefully select patients with few comorbidities and moderate to high preoperative autonomy. In order to achieve a high level of patient satisfaction, it is best to treat only patients with radiculopathy or neurogenic claudication, as these indications demonstrate better outcome than isolated lower back pain [25].

Limitations of the study

The present study reported data from a single-centre retrospective cohort with no control group. The included patients had few comorbidities and this may alter the external validity of this study: the pejorative effect of age may have been minimized due to patient selection. The low number of comorbidities may also have impacted satisfaction rates. Furthermore, the absence of a control group represents a bias regarding the interpretation of patient satisfaction. Besides, no quality of life scores were collected to assess clinical outcome.

Advanced age should not be a contraindication to lumbar spine surgery. This study showed that such procedures were feasible with substantial pain reduction and high patient satisfaction in patients over 85 when careful pre-operative selection was performed.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Ethical approval This retrospective study on patients was approved by the institution institutional review board.

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