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**Original article**

**Minimally invasive unilateral lumbar interbody fusion (UNILIF) in over-80 year-olds.**

**Continuous series of 42 patients at 1.4 years' follow-up**

Mourad **Ould-Slimane**<sup>a</sup>, Pauline **Cantogrel**<sup>a</sup>, Emeric **Lefèvre**<sup>a</sup>, Henry François **Parent**<sup>b</sup>, Rémi  
**Gauthé**<sup>a\*</sup>

<sup>a</sup> CHU de Rouen, Institut Régional du Rachis, Service de Chirurgie Orthopédique et Traumatologique,  
1 Rue de Germont, 76 000 Rouen, France

<sup>b</sup> Clinique Saint-Léonard, 18 Rue de Bellinière, 49800, Trélazé, France.

\* Corresponding author: Rémi Gauthé, Institut Régional du Rachis, Service de Chirurgie  
Orthopédique, 1 Rue de Germont, 76 000 Rouen, France  
[gautheremi@gmail.com](mailto:gautheremi@gmail.com)

# 1 Abstract

**Introduction:** In lumbar stenosis, surgery aims to improve quality of life in increasingly elderly patients. Minimally invasive techniques better suit the requirements of elderly patients with increasing functional demand.

**Hypothesis:** The UNILIF unilateral lumbar interbody fusion technique improves functional scores at 1 year in over-80 year-olds, with low morbidity.

**Method:** Patients undergoing minimally invasive decompression with transforaminal lumbar interbody fusion (TLIF) associated to unilateral pedicle screwing for degenerative lumbar stenosis were analyzed at a minimum 1 year's follow-up. SF12, Oswestry Disability Index (ODI) and Quebec scores and sagittal spinopelvic radiographic parameters were assessed at follow-up. Surgical and general complications were also collated.

**Results:** 42 patients (64.3% female; mean age,  $83.7 \pm 2.9$  years) were treated by UNILIF at levels L2-L3 (3.8%), L3-L4 (15.4%), L4-L5 (71.2%) and L5-S1 (9.6%). Mean follow-up was  $520 \pm 226$  days (range, 340-1,166 days). Mean preoperative SF12 score was  $77.5 \pm 10.9$ , with significant improvement at last follow-up:  $81.9 \pm 13.8$  ( $p < 0.05$ ). Mean preoperative ODI was  $44.4\% \pm 14.0$ , with significant improvement at last follow-up:  $32.4\% \pm 13.3$  ( $p < 0.001$ ). Mean preoperative Quebec score was  $42.9 \pm 19.9$ , with significant improvement at last follow-up:  $28.5 \pm 21.9$  ( $p < 0.001$ ). Spinopelvic sagittal balance was not affected by the UNILIF procedure. There were no cases of infection or severe general complications during follow-up, although 2 cases of non-union required revision surgery.

**Conclusion:** Lumbar stenosis surgery by UNILIF improved functional scores at 1 year, with low morbidity. It is a suitable strategy for degenerative lumbar stenosis in elderly patients.

Level of evidence: IV, non-comparative cohort study

Key-words: Minimally invasive surgery, transforaminal lumbar interbody fusion, unilateral pedicle screw fixation, lumbar stenosis, elderly

## **2 Introduction**

The medical literature on lumbar stenosis treatment is copious. When radiology and clinical findings agree, surgery is commonly reported to be effective [1–3], notably in terms of pain, function and quality of life [4].

Patients are increasingly elderly, with increasing functional demand [5]. In this population, treatment of degenerative lumbar canal stenosis, very largely related to aging, has to weigh efficacy against invasiveness. Regardless of progress in technique and even in concepts, the role of surgery in lumbar stenosis in the elderly needs to be reconsidered. Minimally invasive methods better match these patients' requirements, but few studies have assessed such strategies in the specific geriatric setting [6,7].

The present study aimed to assess results for lumbar canal decompression associated to posterior interbody fusion on a minimally invasive unilateral approach (UNILIF). The main endpoint was functional results at a minimum 1 year's follow-up. Secondary endpoints comprised radiology results and postoperative complications and their impact on clinical outcome.

## **3 Material and methods**

### **3.1 Population**

A single-center continuous retrospective series included over-80 year-old patients receiving UNILIF for lumbar stenosis [8,9] between January 2014 and December 2016. Epidemiological-morphological, functional and radiological data were rendered anonymous and collected prospectively in the Keops® database (SMAIO, Lyon, France), validated for this type of study. Treatment-related complications were collected over a minimum 1-year follow-up. Institutional review-board approval was obtained.

Inclusion criteria comprised treatment by UNILIF, age >80 years, and osteoarthritic lumbar stenosis associated with degenerative spondylolisthesis. Revision surgeries were excluded.

### **3.2 Surgical technique**

Patients were positioned prone. An intermuscular paramedian approach was performed as described by Wiltse et al. [10] ipsilaterally to the most disabling radiculalgia. Under radioscopy guidance, successive dilators were introduced before positioning a tubular distractor to expose the zygapophyseal processes, intervertebral isthmus and interlaminar space. Decompression was achieved via as wide an arthrectomy as necessary and unilateral isthmectomy. Subspinal access extended recalibration more centrally [9], then 2 pedicle screws were introduced ipsilaterally to the approach. After complete discectomy and freshening, an interbody cage was introduced on a transforaminal approach (transforaminal lumbar interbody fusion: TLIF). Autologous bone graft using the laminarthrectomy product was positioned in the interbody space. Strict hemostasis was performed to avoid need for drainage.

### **3.3 Endpoints**

The main endpoint was the clinical result in terms of functional scores: SF12, Quebec Back Pain Disability Scale [11] and Oswestry Disability Index (ODI) [12], scored preoperatively and at last follow-up ( $\geq 1$  year).

Secondary endpoints comprised: epidemiological-morphological data (age, gender, body-mass index (BMI), American Society of Anesthesiologists (ASA) score); surgical data (operating time, blood-loss); and discharge data (referral to follow-up care or rehabilitation center or discharge home); surgery-related complications (surgical revision, infection, dural breach, mechanical failure, postoperative hematoma, etc.) and general complications (severe sepsis, venous thromboembolism, death). Radiographic assessment on EOS imaging was included in the preoperative and last-follow-up work-up (Figure 1a and 1b).

### **3.4 Statistical analysis**

Statistical analysis used Prism<sup>®</sup> software, version 6.01 (GraphPad Software, La Jolla, CA, USA). Quantitative variables were treated as continuous and reported as mean  $\pm$  standard deviation. Qualitative variables were reported as proportions. Matched non-parametric Wilcoxon-Mann-Whitney test was used to compare pre- versus post-operative values.

## 4 Results

### 4.1 Epidemiological-morphological and surgical data (Table 1)

The cohort comprised 42 patients: 35.7% male (n=15), 64.3% female (n=27); mean age,  $83.7 \pm 2.9$  years (range, 80-88 years). Mean BMI was  $26.5 \pm 3.5 \text{ kg.m}^{-2}$  (range, 21.6-37.6).

ASA score was 1 in 5% of cases (n=2), 2 in 60% (n=25), and 3 in 35% (n=15). Only 2 patients (5%) were free of comorbidity; others mainly showed high blood pressure (55%; n=22), lower-limb arteriopathy (30%; n=12), type 2 diabetes (20%; n=8), ischemic cardiopathy or arrhythmia (18%; n=7), history of urologic surgery (18%; n=7), chronic kidney failure (13%; n=5) or cognitive disorder (13%; n=5).

UNILIF concerned levels L2-L3 (3.8%; n=2), L3-L4 (15.4%; n=8), L4-L5 (71.2%; n=37) or L5-S1 (9.6%; n=5). Fixation involved 1 level (80.9%; n=34), 2 levels (14.3%; n=6) or 3 levels (4.8%; n=2). Decompression was performed in all fused levels. Mean operating time was  $91.6 \pm 28.7$  minutes (range, 50-165 min), and mean blood loss  $156 \pm 273 \text{ mL}$  (range, 50-1,600 mL]. There was 1 accidental durotomy. One patient required postoperative blood transfusion. Mean dose-area product (DAP) was  $158.6 \pm 99 \text{ cGy.m}^2$  (range, 43-479 cGy.m<sup>2</sup>). Mean hospital stay was  $4.6 \pm 0.5$  days (range, 4-5 days); all patients were discharged home.

Mean follow-up was  $520 \pm 226$  days (range, 340-1,166 days). Two patients required revision surgery for painful non-union. There were no surgical site infections or deaths during follow-up. General complications comprised: 1 cardiac decompensation in the form of acute pulmonary edema, rapidly resolving under diuretics, 2 urinary infections, and 3 transient confusional states.

### 4.2 Functional scores (Table 2)

Mean preoperative SF12 score was  $77.5 \pm 10.9$  (range, 54-100), with mental component (MCS)  $43.3 \pm 10.7$  and physical component (PCS)  $34.2 \pm 7.4$ . At last follow-up, SF12 were significantly improved, at  $81.9 \pm 13.8$  (range, 58-100) ( $p < 0.05$ ). Mean preoperative ODI was  $44.4 \pm 14.0\%$  (range, 16-68%), with significant improvement at  $32.4 \pm 13.3\%$  (range, 13-58%) ( $p < 0.001$ ). Mean preoperative

Quebec score was  $42.9 \pm 19.9$  (range, 0-83), with significant improvement at  $28.5 \pm 21.9$  (range, 0-73) ( $p < 0.001$ ).

### **4.3 Radiographic data (Table 3)**

Mean pelvic incidence was  $67.1 \pm 16.9^\circ$  and mean lumbar lordosis  $59.1 \pm 17.9^\circ$ . Sagittal spinopelvic alignment was well-balanced, at  $125.4 \pm 10^\circ$ . There were no significant radiographic differences in preoperative to follow-up values. Symptomatic non-union requiring surgical revision, in 2 patients, was not associated with radiographic implant mobilization.

## **5 Discussion**

Symptoms induced by degenerative lumbar canal stenosis are a frequent reason for consultation, in increasingly elderly patients. Several authors advocated decompression and fusion in this aging population [13]. Minimally invasive methods have been little reported, but should be considered.

### **5.1 Technical aspects**

The technique associated canal decompression on a unilateral intermuscular approach [10] to UNILIF fusion [8]. There has been reported to be a learning curve [14], but no particular difficulties arose in the present series. There was no secondary hardware mobilization during follow-up. The side of the surgical approach was the side with the more severe radicular pain. Contralateral decompression could be achieved by subspinal access, but the aim was also to achieve foraminal decompression indirectly by the increase in disc height due to interbody cage positioning [9]. The idea was to avoid performing any contralateral foraminal approach, thereby reducing blood loss and operating time. Associated screwing was intended to increase local stability so as to prevent secondary cage mobilization.

A lateral skin incision was preferred, as medial incision incurs greater risk of skin damage in achieving intermuscular access [15]. Specific tubular distractors are recommended [16]. Only one case of dural breach occurred, without clinical impact. As previously reported by Ross et al., the narrowness of the access did not prevent direct repair by suture and biologic glue [17]. These



posterolateral approaches are even sometimes used to reduce risk of dural lesion in revision surgery [18].

The technique is suited to degenerative pathology localized at between 1 and 3 levels, but is difficult to perform in case of larger involvement. In point of fact, very extensive surgery is rare in geriatric populations.

## **5.2 Advantages of the strategy**

Minimally invasive strategies are intended to reduce surgical morbidity by limiting blood loss and, if possible, operating time. The specific advantage of the Wiltse approach lies in limiting muscle lesion and hence postoperative pain [15]. Not all authors recommend associating decompression to fusion, particularly in the elderly [13]. However, the lumbar canal is recalibrated via arthrectomy, with oblique subspinal access [19], increasing local instability, which is the reason for associating fusion [20]. The present results confirm the feasibility of pedicle screwing and posterolateral and interbody grafting, with no increase in intraoperative morbidity. The interest of unilateral pedicle screwing is confirmed by the satisfactory fusion capacity, similar to that achieved with bilateral fusion in several reports [9, 21–23]. Moreover, operating time is reduced, which is of great interest in an over-80 year-old patient in prone position.

## **5.3 Demographic aspects**

Lumbar stenosis surgery in the elderly was the focus of several encouraging studies. The superiority of minimally invasive strategies is difficult to prove [24], but the concept seems well-suited to the geriatric context. The present selected population was over 80 years of age. Complications tend to be more frequent in case of triple comorbidity, but were no more numerous than in the literature [25]. This confirms the low morbidity reported in the meta-analysis by Xiao et al. [22]. In the same age-group, Rhin et al. reported satisfactory functional results, equivalent to those in younger patients [13]. Osteoporosis incurs a risk of implant instability, although this is less the case with short assemblies. Goldstein et al., in a review of the literature [26], were able to make few recommendations. The gain

in local and regional lordosis achieved with TLIF is not enough to restore overall sagittal spinopelvic balance [27]; but this is rarely the aim in over-80 year-olds.

In this specific population, it is useful to involve a geriatric team in follow-up [28], as proposed by Harari et al. in lower-limb arthroplasty [29].

#### **5.4 Study limitations**

The series was rather small, although its originality is nonetheless of interest in determining the feasibility of UNILIF in over-80 year-olds. There was no control group, and thus no randomization. A multicenter randomized comparative study could determine the role of UNILIF with respect to conventional strategies. Thus, the present functional results, while encouraging, cannot be extrapolated. The learning curve was not taken into account, as all procedures were performed by the same surgeon, experienced in the technique. Analysis of postoperative complications could have been more exhaustive if a geriatric analysis had been associated; even so, all identified events were reported. Analysis of bone fusion and possible cage impaction was not available for this retrospective cohort. Systematic control CT was not part of current practice in these elderly patients if they showed no symptoms that would require such imaging.

### **6 Conclusion**

Lumbar stenosis surgery by UNILIF is feasible in over-80 year-olds. In the present series, it improved functional scores, with little morbidity. Its efficacy and rapid recovery time as reported in the literature make it a suitable option in degenerative lumbar pathology in elderly patients.

**Conflicts of interest:** none

**Funding:** none

**Author contributions:**

Ould-Slimane and Gauthé: article writing, supervision

Parent: surgery, data collection

Lefevre, Cantogrel: data collection, statistical analysis, Keops radiography

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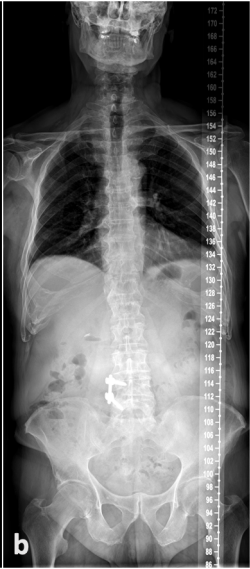
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**Figure 1:** EOS lateral (a) and AP (b) views of level L4-L5 UNILIF.



**Table 1:** Epidemiological-morphological and surgical data

	<b>N (%) or mean <math>\pm</math> SD [range]</b>
<b>Epidemiological-morphological data</b>	
Age (years)	83.7 $\pm$ 2.9 [80 ; 88]
Sex ratio (M/F)	0.56
BMI (kg.m <sup>-2</sup> )	26.5 $\pm$ 3.5 [21.6 ; 37.6]
<b>Comorbidity</b>	
ASA score = 1	2 (5)
ASA score = 2	25 (60)
ASA score = 3	15 (35)
HBP	22 (53)
OALL	12 (29)
Type 2 diabetes	8 (19)
Cardiopathy	7 (17)
History of urologic surgery	7 (17)
Chronic kidney failure	5 (12)
Cognitive disorder	1 (2)
<b>Surgical data</b>	
Extent (number of patients)	42 (100)
1 level	34 (80.9)
2 levels	6 (14.3)
3 levels	2 (4.8)
Levels	52 (100)
L2-L3	2 (3.8)
L3-L4	8 (15.4)
L4-L5	37 (71.2)
L5-S1	5 (9.6)
Operating time (min)	91.6 $\pm$ 28.7 [50 ; 165]
Blood loss (ml)	156 $\pm$ 273 [50 ; 1,600]
Accidental durotomy	1 (2.4)
DAP (cGy.cm <sup>2</sup> )	158.6 $\pm$ 99 [43 ; 479]
Hospital stay (days)	4.6 $\pm$ 0.5 [4 ; 5]
Follow-up (days)	520 $\pm$ 226 [213 ; 1,166]

*SD: standard deviation*

*BMI: body-mass index*

*ASA: American Society of Anesthesiologists*

*HBP: high blood pressure*

*OALL: obliterating arteriopathy of the lower limbs*

*DAP: dose-area product*



**Table 2:** Functional scores

Mean $\pm$ SD [range]	Preoperative	Last follow-up	p *
SF12	77.5 $\pm$ 10.9 [54 ; 100]	81.9 $\pm$ 13.8 [58 ; 100]	< 0.05
PCS	34.2 $\pm$ 7.4	39 $\pm$ 9	
MCS	43.3 $\pm$ 10.7	42.9 $\pm$ 9.7	
ODI	44.4 $\pm$ 14.0 [16 ; 68]	32.4 $\pm$ 13.3 [13 ; 58]	< 0.001
Quebec score	42.9 $\pm$ 19.9 [0 ; 83]	28.5 $\pm$ 21.9 [0 ; 73]	< 0.001

*SD: standard deviation*

*SF 12: 12-item Short Form health survey*

*PCS: physical component summary scale score*

*MCS: mental component summary scale score*

*ODI: Oswestry Disability Index*

*\* Matched Wilcoxon test*

**Table 3:** Spinopelvic balance

Mean $\pm$ SD [range]	Preoperative	Last follow-up	p *
<b>Pelvic parameters</b>			
Pelvic incidence (°)	67.1 $\pm$ 16.9		
Pelvic version (°)	25.9 $\pm$ 8.6	23.4 $\pm$ 9.3	NS
Sacral slope (°)	41.2 $\pm$ 11.1	39.8 $\pm$ 9.1	NS
Lumbosacral angle (°)	-9.6 $\pm$ 10.3	-9.4 $\pm$ 10.4	NS
<b>Spinal parameters</b>			
Lumbar lordosis (°)	59.1 $\pm$ 17.9	60.7 $\pm$ 13.4	NS
Thoracic kyphosis (°)	55.5 $\pm$ 14.6	63.1 $\pm$ 12.4	NS
Cervical lordosis (°)	15.3 $\pm$ 13.7	23 $\pm$ 9.3	NS
<b>Sagittal balance</b>			
d/D ratio	1.1 $\pm$ 0.6	1.1 $\pm$ 0.5	NS
C7 sagittal offset (mm)	6.3 $\pm$ 3	5.2 $\pm$ 2.4	NS
Spinosacral angle (°)	125.4 $\pm$ 10.6	124.6 $\pm$ 9.3	NS

*SD: standard deviation*

*NS: non-significant*

*\* Matched Wilcoxon test*