

Dynamic Stabilization for Degenerative Lumbar Scoliosis in Elderly Patients

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Study Design. A retrospective study.

Objective. To analyze outcomes after dynamic stabilization without fusion in degenerative lumbar scoliosis in elderly patients.

Summary of Background Data. Frequent complications of posterolateral instrumented fusion have been reported after treatment of degenerative lumbar scoliosis in elderly patients. The use of dynamic stabilization without fusion can be advocated to reduce such adverse effects, being less invasive, with shorter operation time and less blood loss. No study in the literature has analyzed outcomes of dynamic stabilization without fusion in these degenerative deformities.

Methods. Twenty-nine elderly patients (average age, 68.5 years; range, 61–78) with degenerative lumbar scoliosis, undergoing dynamic stabilization (Dynesys system) without fusion combined with decompressive laminectomy, in cases with associated stenosis, were analyzed. Stenosis of the vertebral canal was associated in 27 patients (93.1%); 13 cases (44.8%) also presented a degenerative spondylolisthesis. An independent spine surgeon retrospectively reviewed all the patients' medical records and radiographs to assess operative data and surgery-related complications. Preoperative, postoperative, and follow-up questionnaires were obtained to evaluate clinical outcomes.

Results. The mean follow-up time was 54 months (range, 39–68). Oswestry Disability Index, Roland Morris Disability Questionnaire, and back pain and leg pain visual analogue scale scores received a statistically significant improvement at last control; the mean improvement was 51.6% for Oswestry Disability Index ($P = 0.01$), 58.2% for Roland Morris Disability Questionnaire ($P = 0.01$), 51.7% for leg pain ($P = 0.02$), and 57.8% for back pain ($P = 0.01$). Radiographically, degenerative scoliosis and associated spondylolisthesis resulted stable at follow-up with a moderate correction: the average scoliosis Cobb angle was 16.9° (range, 12°–37°) before surgery and 11.1° (range, 4°–26°) at last follow-up, with a 37.5% mean correction ($P = 0.01$); the anterior vertebral translation was 18.9% (range, 12%–27%) before surgery and 17% (range, 0%–27%) at follow-up, for a 14.6% mean correction

(range, 0%–100%) ($P = 0.02$). No implant-related complications (screw loosening or breakage) or loss of correction were observed. Four cases (13.8%) presented an asymptomatic radiolucent line around screws of the S1 level without screw loosening. Six patients (20.7%) showed minor complications (ileus in 2 cases, urinary tract infection in 2, transient postoperative delirium in one, and respiratory difficulties after surgery in another patient). In 2 other patients (6.8%) incurred major complications, both requiring a revision surgery, for a misplaced screw on L5 and junctional disc degeneration at the lower level respectively. No neurologic complications occurred.

Conclusion. Dynamic stabilization with pedicle screws in addition to decompressive laminectomy resulted a safe procedure in elderly patients with degenerative lumbar scoliosis; it was able to maintain enough stability to prevent progression of scoliosis and instability, enabling a wide laminectomy in cases of associated lumbar stenosis. This nonfusion stabilization technique was less aggressive than instrumented fusion and obtained a statistically significant improvement of the clinical outcome at last follow-up.

Key words: degenerative lumbar scoliosis, dynamic stabilization, Dynesys system, decompressive laminectomy. **Spine** 2010;35:227–234

Degenerative lumbar scoliosis, described as *de novo* scoliosis, occurs in later life. These curves, also called “primary degenerative scoliosis,”¹ are located at thoracolumbar or lumbar level and need to be distinguished from degenerated preexisting idiopathic scoliosis—in fact *de novo* scoliosis are developing after skeletal maturity without previous history of scoliosis. Asymmetric degenerative changes of the disc, vertebral body wedging, and facet joint arthrosis are responsible for its appearance.^{1,2} A recent prospective study² investigated 60 adults aged between 50 to 84 years, without previous scoliosis; within 12 years, 22 cases (36.7%) developed *de novo* scoliosis with a mean angle of 13°. A previous study reported a similar incidence—Robin *et al*³ followed 160 adults with straight spine for more than 7 years and found 55 cases of *de novo* scoliosis (34.4%).

The surgical treatment of these deformities included more often a posterolateral fusion with pedicle screw instrumentation in addition to decompression of neural elements^{1,4–8} In most series, the incidence of complications is high, ranging from 20% to 80%.^{1,5,7,8} The impact of different factors on the complications rate remains unclear and there are conflicting results in the literature.^{5,7–14} Older age (above 65 years), medical comorbidities, increased blood loss, and number of levels fused seem to play an important role. Among these, ex-

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cessive intraoperative blood loss seems to be the most significant risk factor for early perioperative complications.⁷ Accordingly in elderly patients the surgery should be the least aggressive possible and the length of the surgical procedure should be considered very carefully.¹³ A surgical treatment based on decompression alone presented poor results, related to progression of symptoms and deformity.¹⁵ At the same time, adding an arthrodesis to the decompression procedure increases the operative time and blood loss, and consequently can increase the complications rate.^{5,9,14}

The use of dynamic stabilization without fusion has been advocated to reduce such adverse effects, being less invasive, with shorter operation time and less blood loss. In 1994, Dubois *et al*¹⁶ introduced a new dynamic stabilization system (Dynesys; Zimmer Spine, Minneapolis, MN) consisting of titanium alloy screws connected by an elastic synthetic compound (polycarbonate-urethane spacers and polyester cords)—the authors claimed that with this system stabilization is possible without bone grafting. Schmoelz *et al*¹⁷ investigated Dynesys in an *in vitro* study: they concluded that Dynesys is capable of sufficiently stabilize an unstable spine segment, and can be considered as an alternative to fusion surgery. Few studies presented the results for patients who underwent decompression and stabilization with Dynesys instrumentation for a degenerative spondylolisthesis, obtaining a stable fixation in a great number of cases.^{18–22} No study in the literature analyzed outcomes of dynamic stabilization for degenerative lumbar scoliosis.

The purpose of this study was to assess the results of decompression and dynamic stabilization without fusion in elderly patients affected by degenerative lumbar scoliosis to determine complications and to evaluate patients' clinical outcomes.

■ Materials and Methods

The Dynesys Spinal System

The Dynesys system consists of titanium alloy pedicle screws (Protasul 100), polyethylen-terephthalat cords (Sulene-PET), and polycarbonate urethane spacers (Sulene-PCU), which fit between the pedicle screw heads (Figure 1).

Surgical Treatment

Four experienced spine surgeons of our department performed all surgeries. Antibiotic therapy started 12 hours before surgery and was maintained for an average of 8 days (range, 7–10). The patients were treated under general anesthesia in the prone position. In cases with associated stenosis of the vertebral canal, patients' hips were flexed at an angle of 90° to perform the decompression of the stenotic levels, removing the laminae for a wide laminectomy; the decompression was extended to the lateral recess, and foraminotomy was performed without interrupting the isthmus. After decompression the position of the patient was modified to obtain the maximum lumbar lordosis.

Titanium alloy pedicle screws were inserted, generally using 6.0 mm diameter screws for lumbar vertebrae and 7.2 mm diameter screws for the sacrum. The pedicles screw diameter was defined according to the preoperative radiograph of the lumbar spine. Hydroxyapatite (HA)-coated screws were gener-

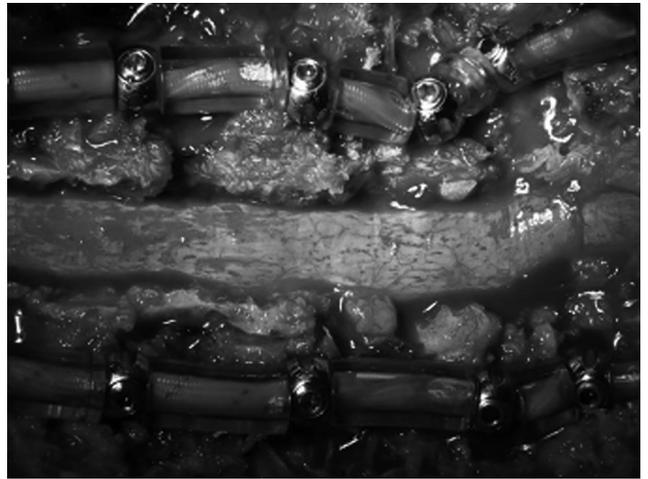


Figure 1. The dynamic stabilization (Dynesys system) without fusion combined with decompressive laminectomy.

ally used in older patients. They were implanted only in the sacrum of 4 patients older than 70 years; therefore, 8 HA coated screws were used out of the 18 screws implanted in the S1 level (44%) and out of a total of 274 screws used in this study (2.9%). The pedicle entry point was lateral, at the basis of the transverse process, with a convergence angle between 13° and 18°. In the sacrum the screw was directed with the tip to the proximal plateau of S1. The screws were inserted as deep as possible. We always avoided removing and reinserting the screws in the same place, due to the conical core of the screws, which meant losing the bone purchase. Polycarbonate urethane spacers were cut and inserted together with the polyester cord, and the system was tightened. Asymmetric spacers, larger than requested on the concave side and shorter on the convex side of the scoliosis curve, were inserted, always paying attention to the lumbar lordosis, that was guaranteed by the position of the patient on the operating table. Two deep Redon drains were applied and maintained for a mean duration of 3.7 days (range, 3–4).

Patient Evaluation

A retrospective review, based on a database search, was performed to identify all patients who had undergone posterior decompression and dynamic fixation (Dynesys system) at our department between January 2002 and December 2004. Inclusion criteria were as follows: (1) diagnosis of degenerative lumbar scoliosis; (2) minimum age at surgery of 60 years; (3) Cobb angle of more than 10° before surgery; (4) no improvement after conservative treatment; (5) no previous lumbar fusion or stabilization surgery; (6) minimum follow-up of 3 years.

An independent spine surgeon reviewed all the selected patients' medical records and radiographs. Inpatient and outpatient charts were used for the collection of demographic data, preoperative data (location of pain, neurologic symptoms, previous surgeries), perioperative data (blood loss, surgical time, length of hospital stay, and any medical- and surgical-related complications), and postoperative data, including revision surgeries.

Radiographic evaluation included preoperative CT and MRI of the lumbar spine, as well as standing plain and functional films with flexion and extension views before surgery, after surgery, and at last follow-up. Overall lumbar measures from the radiographs included Cobb angle of the lumbar curve,

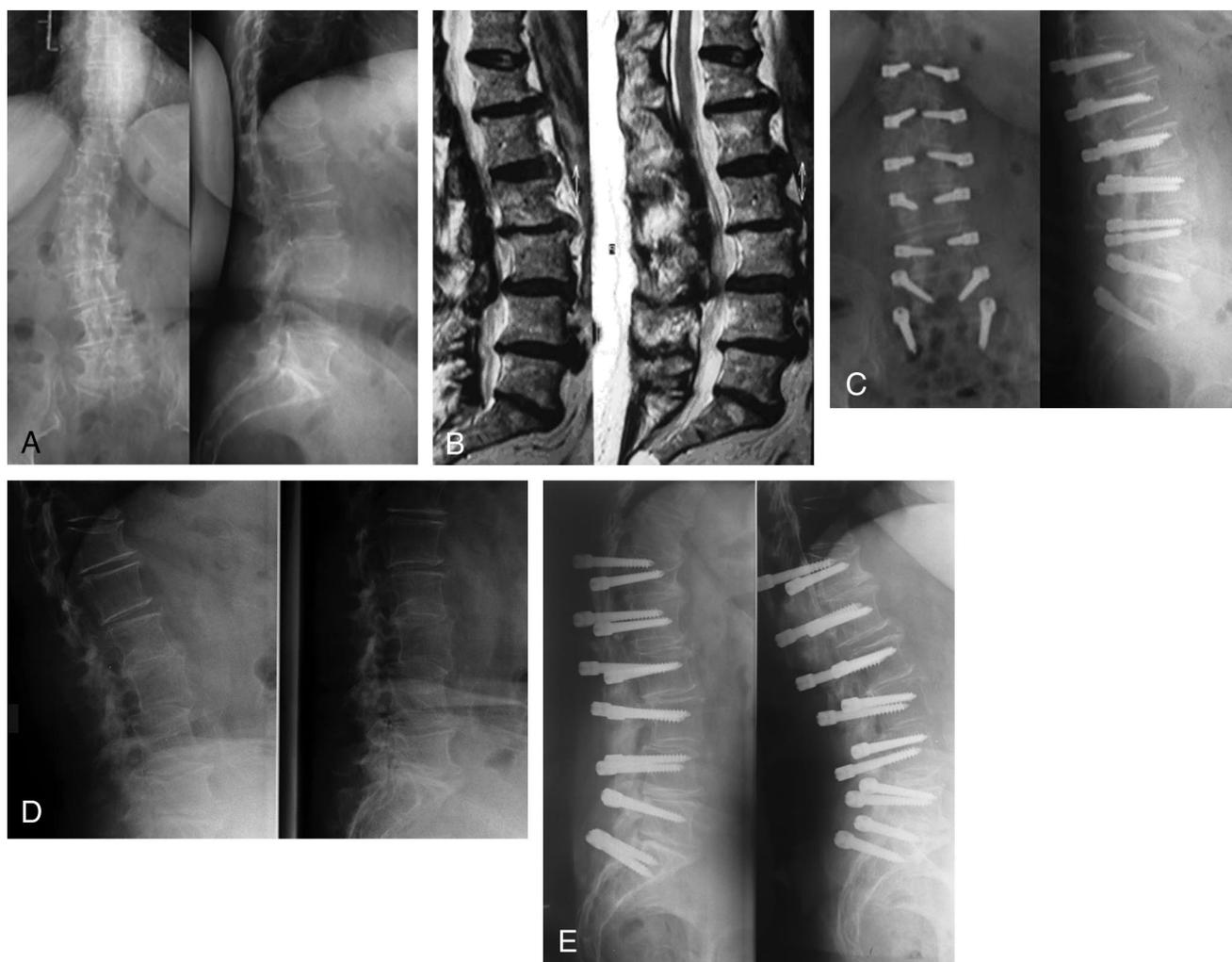


Figure 2. A 75-year-old woman. Degenerative lumbar scoliosis associated with stenosis of the vertebral canal and spondylolisthesis at L3–L4 (A, B). Treatment: T12–S1 dynamic fixation and L3–L5 laminectomy. Three-year postoperative radiographs showing stable implant in standard radiographs (C). The comparison of flexion/extension radiographs before surgery (D) and at last follow-up (E) show that a few degrees of motion were preserved.

lumbar lordosis (T12–S1), and thoracolumbar junction alignment (T10–L2), lateral listhesis of apical vertebra and anterior vertebral translation in the cases with associated spondylolisthesis. Instrumentation loosening or breakage and degenerative alterations of adjacent levels were also noted. Range of motion at segments treated with dynamic fixation was assessed before surgery and at last follow-up, by calculating the difference between segmental alignment on the flexion and extension films measured from lines drawn along the inferior endplates of adjacent vertebral bodies; for the L5–S1 segment, the inferior endplate of L5 and superior endplate of S1 were used for measurement (Figures 2D, E).

Questionnaires

Clinical outcome was assessed by means of the Oswestry Disability Index (ODI), Roland Morris Disability Questionnaire (RMDQ), and visual analogue scale (VAS) for back and leg pain, filled in by patients before surgery, after surgery, and at last follow-up.

Statistical Evaluation

The clinical and radiologic results were analyzed using the *t* test. Results are expressed as the mean (range), with a *P* value of <0.05 considered as being statistically significant.

Results

Preoperative Patient Data

A total of 29 patients were included in the study, reviewed at a mean follow-up time of 54 months (range, 39–68). There were 7 men (24.1%) and 22 women (75.9%), with a mean age of 68.5 years (range, 61–78). Average body mass index was 26.4 (range, 20–36). Number of comorbidities was 1.6 ± 0.7 per patient. Medical comorbidities included diabetes mellitus in 11 cases, heart disease in 6, arterial hypertension in 15, liver disease in 6, and pulmonary disease in 5 patients. At the time of surgery all patients complained of leg pain. Twenty-seven patients (93.1%) presented with neurogenic claudication and 21 (72.4%) complained of back pain. After conservative treatment conducted for more than 12 months, they showed no improvement.

All 29 patients presented a degenerative lumbar scoliosis, associated in 27 cases (93.1%) with a stenosis of the vertebral canal. Thirteen patients (44.8%) presented also with degenerative spondylolisthesis, located at

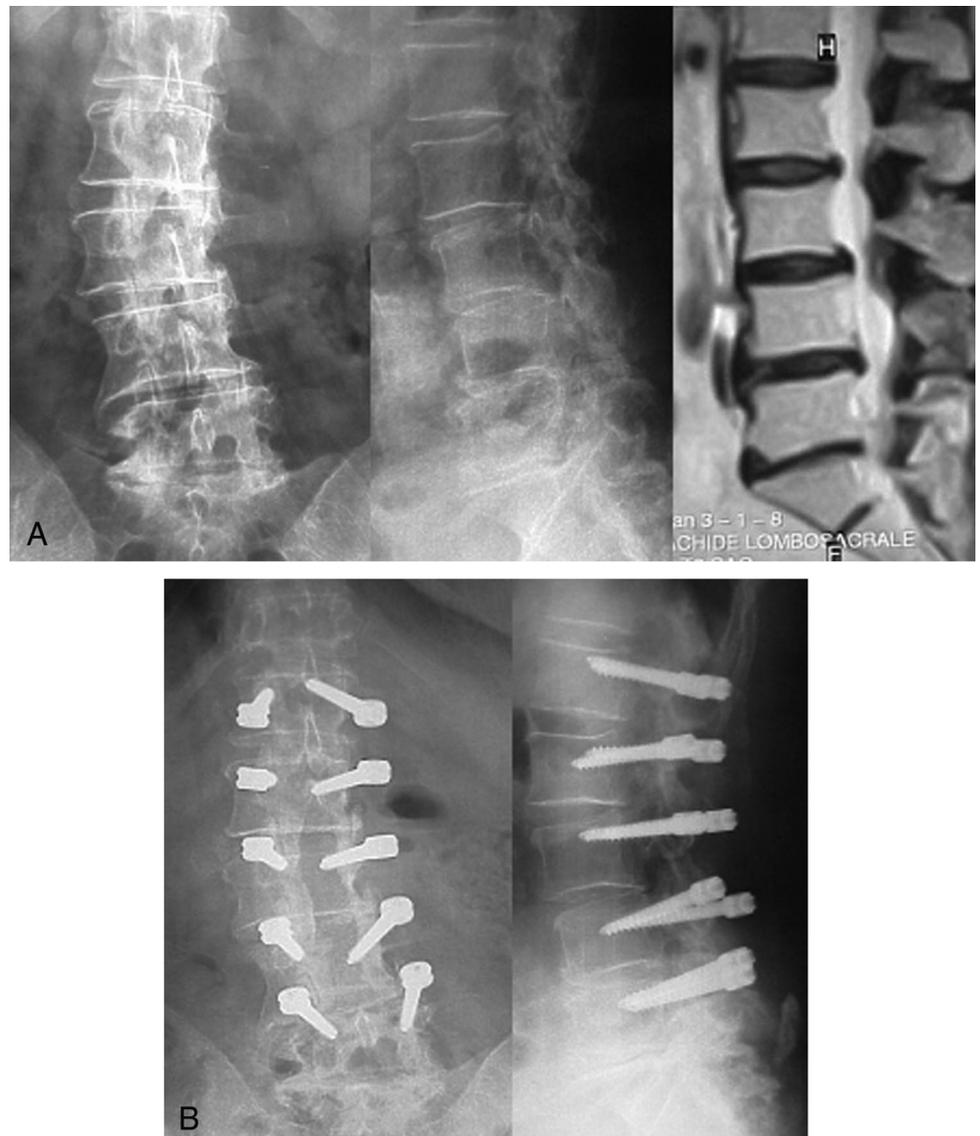


Figure 3. A 73-year-old woman. Degenerative lumbar scoliosis associated with stenosis of the vertebral canal and spondylolisthesis at L3–L4 (A). Treatment: L1–L5 dynamic fixation and L3–L4 laminectomy. Three year and 6 months postoperative radiographs showing stable implant and no progression of scoliosis (B).

L2–L3 in 1 case, at L3–L4 in 8 patients, at L4–L5 in 3 cases and at L5–S1 in 4 cases (3 patients showed spondylolisthesis at 2 levels)—the mean slippage was 18.9% (range, 12%–27%). Eleven patients (37.9%) had undergone a previous spine surgery, including 10 decompressions and 6 discectomies (7 patients had undergone 1 previous operation, 3 cases 2 operations, and 1 patient had 3 previous surgeries).

Perioperative Data

All patients were stabilized using Dynesys system without fusion (Figures 1–3). Fixation was extended at 3 levels in 18 patients (62.1%: L1–L4 in 3 cases, L2–L5 in 10, L3–S1 in 5), at 4 levels in 5 cases (17.2%: L1–L5 in 3, L2–S1 in 2), at 5 levels in 2 cases (6.9%: T12–L5 in 1 case, L1–S1 in 1), and at 6 levels in 4 patients (13.8%: T12–S1).

In 27 patients (93.1%) the stabilization was combined with a wide decompressive laminectomy, performed at 2 levels in 4 cases (14.8%: L2–L3 in 1 patient, L3–L4 in 1, L4–L5 in 2), at 3 levels in 8 cases (29.6%: L2–L4 in 3,

L3–L5 in 5), at 4 levels in 7 cases (25.9%: L2–L5 in 6 cases, L3–S1 in 1 case), at 5 levels in 5 cases (18.5%: L1–L5 in 2 cases, L2–S1 in 3 cases), and at 6 levels in 3 cases (11.1%: T12–L5 in 2 patients, L1–S1 in 1). The associated spondylolisthesis has always been included in the area of stabilization.

Mean operating time was 190 minutes (range, 130–330), while mean length of hospital stay was 6.7 days (range, 6–9). Mean blood loss was 935 mL (range, 250–1600). Patients were allowed to get up 2.7 days after surgery (range, 2–4) whereas a lumbar orthosis was prescribed for 1 month.

Clinical Outcome

All 29 patients included in the study have properly filled out questionnaires before surgery, in the postoperative period and at last follow-up (Table 1). The mean follow-up was 54 months (range, 39–68).

The mean preoperative ODI score was 51.8% (range, 28%–80%) and the mean postoperative score was 27.4% (range, 0%–66%), while at last follow-up score

Table 1. Clinical Outcome

	Preoperative	Postoperative	Follow-up	% Follow-up Correction	P
ODI (%)	51.8 (28–80)	27.4 (0–66)	28 (0–70)	51.6 (12.5–100)	0.01
RMDQ (n/24)	12.5 (7–22)	6.1 (0–19)	6.4 (0–20)	58.2 (9.1–100)	0.01
VAS back pain (%)	66.8 (30–100)	33.1 (2–75)	33.9 (2–79)	57.8 (20–96.5)	0.01
VAS leg pain (%)	67.8 (30–100)	40.2 (2–90)	41.5 (2–90)	51.7 (10–96.4)	0.02

ODI indicates Oswestry Disability Index; RMDQ, Roland Morris Disability Questionnaire; VAS, Visual Analog Scale.

was 28% (range, 0%–70%), for a 51.6% mean improvement (range, 12.5%–100%), that resulted statistically significant ($P = 0.01$).

The mean preoperative RMDQ score was 12.5 (range, 7–22) and the mean postoperative score was 6.1 (range, 0–19), while at last follow-up it was 6.4 (range, 0–20), for a 58.2% mean improvement (range, 9.1%–100%), that was statistically significant ($P = 0.01$).

Mean leg pain on VAS decreased from a preoperative score of 67.8 (range, 30–100) to a mean postoperative score of 40.2 (range, 2–90) and to a score of 41.5 (range, 2–90) at last follow-up, for a 51.7% mean improvement (range, 10%–96.4%), while the mean back pain on VAS decreased from a preoperative score of 66.8 (range, 30–100) to a postoperative score of 33.1 (range, 2–75) and finally to 33.9 (range, 2–79) at last follow-up, for a 57.8% mean improvement (range, 20%–96.5%). Both improvements resulted statistically significant ($P = 0.02$ and $P = 0.01$, respectively).

Radiologic Outcome

Preoperative radiographic documentation (radiographs, CT scan, and MRI) as well as plain and functional radiographs after surgery and at last follow-up were analyzed for all 29 patients (Table 2).

The average scoliosis Cobb angle was 16.9° (range, 12°–37°) before surgery, 10.9° (range, 4°–25°) after surgery, and 11.1° (range, 4°–26°) at last follow-up, with a statistically significant mean correction of 37.5% (range, 11.1%–61.5%) ($P = 0.01$). Lumbar lordosis was –31.6° (range, 3° to –50°) before surgery, –36.4° (range, –12° to –55°) after surgery, and –36.0° (range, –10° to –55°) at last follow-up (n.a.), while thoracolumbar junction alignment (T10–L2) was –2.7° before surgery (range, –25° to 23°), –0.1° (range, –18° to 25°) after surgery, and –0.3° (range, –18° to 25°) at last follow-up (n.a.). The apical vertebra lateral listhesis was 1.1 cm (range, 0.2–1.8 cm) before surgery, 0.7 cm (range, 0.2–1.1 cm) after surgery, and 0.8 cm (range,

0.2–1.2 cm) at last follow-up, with a statistically significant correction that averaged 29.7% (range, 0%–44.4%) ($P = 0.04$).

In cases with associated spondylolisthesis, the anterior vertebral translation was 18.9% (range, 12%–27%) before surgery, 16.6% (range, 0%–25%) after surgery, and 17% (range, 0%–27%) at follow-up, with a statistically significant mean correction of 14.6% mean (range, 0%–100%) ($P = 0.02$).

The range of motion at each level stabilized with dynamic fixation was evaluated on flexion/extension radiographs before surgery and at last follow-up (Table 3). Some degrees of motion were preserved after stabilization at different levels, mainly at L4–L5 and at L2–L3 levels.

Asymptomatic radiolucent lines up to 2 mm around the thread of the pedicle screws in the sacrum were seen in 4 cases (13.8%) without screw loosening. These screws were not considered to be loose as no movement could be seen on flexion/extension radiographs; they were all non-HA coated. No implant-related complications (screw loosening or breakage) or loss of correction were observed.

Complications

No neurologic complications were observed. Six patients (20.7%) presented minor complications. Two ileus cases (6.9%) and 2 urinary tract infection cases (6.9%), were resolved after medical treatment. Another patient (3.4%) presented a transient postoperative delirium that was resolved after 3 days. One patient (3.4%) developed respiratory difficulties after surgery, requiring 5 days of recovery in the intensive care unit for the complete resolution of the dyspnea.

Two other patients (6.8%) presented major complications, requiring a revision surgery. One patient (3.4%) developed severe postoperative sciatica, without neurologic deficit, not controlled by medication, due to a misplaced screw on L5; revision surgery with replacement of

Table 2. Radiologic Outcome

	Preoperative	Postoperative	Follow-up	% Follow-up Correction	P
Scoliosis (°)	16.9 (12/37)	10.9 (4/25)	11.1 (4/26)	37.5 (11.1/61.5)	0.01
Lordosis (°)	–31.6 (3/–50)	–36.4 (–12/–55)	–36.0 (–10/–55)	NA	NA
T10–L2 alignment (°)	–2.7 (–25/23)	–0.1 (–18/25)	–0.3 (–18/25)	NA	NA
AV lateral listhesis (cm)	1.1 (0.2/1.8)	0.7 (0.2/1.1)	0.8 (0.2/1.2)	29.7 (0/44.4)	0.04
Anterior vertebral translation (%)	18.9 (12/27)	16.6 (0/25)	17 (0/27)	14.6 (0/100)	0.02

NA indicates not available.

Table 3. Range of Motion at Each Level Stabilized, Evaluated on Flexion/Extension Radiographs Before Surgery and at Last Follow-up (°)

	Cases	Preoperative	F/U
T12–L1	5	1.3° (0–3)	0.6° (0–1)
L1–L2	12	3.9° (2–6)	1.9° (1–4)
L2–L3	24	4.2° (3–6)	2.3° (1–4)
L3–L4	29	3.3° (2–5)	1.5° (1–3)
L4–L5	26	4.8° (3–7)	2.7° (2–4)
L5–S1	12	1.8° (0–3)	0.8° (0–2)

the misplaced screw was performed 5 days after the first operation, with complete resolution of the sciatica. Another patient (3.4%) developed persistent sciatica, without neurologic deficit, not controlled by medication, 28 months after surgery, due to a junctional disc degeneration at the lower level—revision surgery was performed 32 months after the first operation, with extension of fixation and decompression from L5 to S1.

No implant related complications (screw loosening or breakage) were observed at follow-up.

■ Discussion

The surgical treatment of degenerative lumbar scoliosis often consisted of posterolateral fusion with pedicle screw instrumentation in addition to decompression.^{1,4–8} The aim of surgery is to decompress the neural elements, in case of associated symptomatic spinal stenosis, and to balance the spine in the coronal and sagittal plane. However, elderly patients present a lot of medical comorbidities, and surgical treatment should be performed as less aggressive as possible.⁶ Length of surgical procedure and blood loss should be considered very carefully. Previous studies have shown increased complications rate in older patients who underwent spinal fusion procedures^{5,7,9,11–14,23} Deyo *et al*⁹ reported that patients over 75 years of age undergoing spinal fusion showed a complication rate 1.9 times greater than those who had surgery without fusion. Carreon *et al*⁵ reported an 80% overall complications rate and a 21% major complications rate in a group of 101 patients of 65 years of age or older treated by posterior decompression and lumbar instrumented arthrodesis; older age and the number of fused levels were identified as risk factors for the development of a complication. In a group of patients aged 80 years or older who underwent lumbar arthrodesis, Raffo and Lauerma¹¹ showed a 20% major complications rate; comorbidities, length of hospital stay, and intensive care stay were the only factors that correlated significantly with the presence of an inpatient complication. Daubs *et al*¹² revised 46 patients with an age of 60 years or older who underwent a spinal deformity reconstructive procedure and reported a 37% overall complication rate and a 20% major complication rate. In this study it appears that the age is correlated with an increased complications rate and that patients older than 69 years are 9 times more likely to have major complications. Cho *et*

*al*⁷ analyzed 47 patients (average age, 66.6 years) with degenerative lumbar scoliosis treated by posterior fusion and instrumentation. The overall complications rate was 68% and the major complications rate was 55%; excessive blood loss was the most significant risk factor for the development of early complications.

The use of dynamic stabilization without fusion can be advocated to reduce such complications, being less invasive, with shorter operation time and less blood loss. In our series the mean operating time was 190 minutes (range, 130–330 minutes) and the mean blood loss was 935 mL (range, 50–1600 mL). These numbers are lower than in series of patients treated with posterior instrumented fusion.^{7,12}

No previous study in the literature analyzed outcomes of dynamic stabilization in degenerative lumbar scoliosis in elderly patients. Dynamic system or soft stabilization devices without fusion have been used for the treatment of degenerative spondylolisthesis—these procedures have been advocated as nonfusion alternatives to spinal arthrodesis. The results of Graf ligaments (a pair of daron ligaments connecting pedicle screws across the motion segments) were often unsatisfactory.^{24–28} The Graf system did not prevent postoperative instability, with high percentage of destabilization of the operated segments²⁴; it was associated with a worse outcome and a significantly higher revision rate than posterolateral fusion with pedicle screws,²⁵ and did not present mid- to long-term results as encouraging as the short-term ones.²⁶ Recently, Kanayama *et al*²⁸ concluded that the spinal ligamentoplasty cannot completely replace the spinal fusion. Better results were achieved using Dynesys system in the treatment of degenerative spondylolisthesis,^{18–22} obtaining no significant progression and a stable implant in a great number of cases. In our study the radiologic evaluation at follow-up revealed that the dynamic fixation provided a substantial stability by preventing further scoliosis progression or vertebral translation of associated spondylolisthesis after wide laminectomy. The scoliosis Cobb angle presented at last control a minimum correction also, because asymmetric spacers were chosen, larger than requested on the concave side and shorter on the convex side of the scoliosis curve. No cases with implant related complications (screws loosening or breakage) or loss of correction were observed. However, asymptomatic radiolucent lines up to 2 mm around the thread of pedicle screws in the sacrum were shown in 4 cases (13.8%) at follow-up, without screw loosening.

The overall rate of complications was low in our series. Six patients (20.7%) presented minor complications that resolved by itself or by medication within a few days. Two other patients (6.8%) incurred major complications, both requiring a revision surgery, one for a misplaced screw on L5 and the other for a junctional disc degeneration at the lower level. Radiologic signs of adjacent disc degeneration were documented in this patient only. The theoretical protection of adjacent segment de-

generation has been documented in our study, with a minimum follow-up of 3 years. One previous study concluded that a dynamic stabilization system can prevent degeneration of the adjacent segment.²⁹ Instead, the results of the study of Schnake *et al*²⁰ after Dynesys instrumentation in degenerative spondylolisthesis did not support this theory; these authors found signs of degeneration adjacent to the stabilized segment in 29% of the cases 2 years after surgery. However, longer follow-up studies are needed for definitive conclusions.

With the dynamic procedure it was possible to maintain a stable and satisfying lumbar lordosis at follow-up. However, dynamic stabilization is indicated in cases of degenerative lumbar scoliosis with a satisfying preoperative sagittal balance: the position of the patient on the operating table was always assessed to maintain or to increase the lumbar lordosis. In cases with sagittal imbalance it is very difficult to obtain a normal lumbar lordosis by using dynamic stabilization alone and different surgical techniques such as corrective osteotomy and/or instrumented posterior fusion should be considered before surgery.

In our patients it is difficult to distinguish the clinical benefits from the decompression and those from the dynamic stabilization. Schnake *et al*,²⁰ after using the Dynesys system in degenerative spondylolisthesis, concluded that the clinical outcome of their patients mainly relied on the efficacy of neural decompression. However, in degenerative scoliosis the surgical treatment should include both decompression and stabilization of the spine,⁶ because decompression alone can present poor results, related to progression of symptoms and deformity.¹⁴ Clinical outcome of our patients improved significantly after decompression and dynamic stabilization of the spine, at a mean follow-up of 54 months (range, 39–68) (Table 2). The preoperative ODI score presented a 51.6% mean improvement at follow-up ($P = 0.01$). The preoperative RMDQ score had a 58.2% mean improvement at last visit ($P = 0.01$). Leg pain on VAS had at follow-up a 51.7% mean improvement while back pain on VAS decreased at last follow-up with a 57.8% mean improvement: both improvements were statistically significant ($P = 0.02$ and $P = 0.01$, respectively). Our clinical outcome after dynamic stabilization without fusion are favorably comparable with the results obtained by other authors for degenerative scoliosis, using posterior instrumented fusion.^{10,12}

■ Conclusion

The present series should be interpreted in the context of its limitations, including the retrospective nature of the review and the fact that patients were not randomized between dynamic fixation without fusion and posterior instrumented fusion. However, dynamic stabilization with pedicle screws in addition to decompressive laminectomy proved to be a safe procedure in elderly patients with degenerative lumbar scoliosis; it was able to maintain enough stability to prevent scoliosis pro-

gression and instability and enabled a wide laminectomy, obtaining a statistically significant improvement of the clinical outcome.

This nonfusion stabilization technique resulted less invasive with shorter operation time and less blood loss than instrumented posterior fusion.

■ Key Points

- Elderly patients present a lot of comorbidities, and surgical treatment of degenerative lumbar scoliosis should be performed with the least aggressive procedure.
- Twenty-nine elderly patients (average age, 68.5 years; range, 61–78) with degenerative lumbar scoliosis, undergoing dynamic stabilization (Dynesys system) without fusion combined with decompressive laminectomy, in cases with associated stenosis, were analyzed.
- Dynamic stabilization with pedicle screws proved to be a safe procedure; it was able to maintain enough stability to prevent scoliosis progression and instability, and enabled a wide laminectomy, in cases with associated stenosis of the vertebral canal.
- This nonfusion stabilization technique resulted less aggressive than instrumented fusion.

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