Results of Minimally Destabilizing Laminotomy using Spinous Process Osteotomy for Mild Lumbar Degenerative Spondylolisthesis
—2-year minimum follow up of decompression alone—

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Introduction

The operative management of degenerative lumbar spondylolisthesis with spinal stenosis has remained controversial, despite a clearer understanding of its pathogenesis and pathology¹⁻³. The benefits of decompression and arthrodesis for the treatment of lumbar spinal stenosis related to spondylolisthesis have been well studied and many authors have advocated that spinal arthrodesis be performed concomitantly with decompression⁴⁻⁷; however, other authors have reported satisfactory results with decompression alone⁸⁻¹⁰. It is difficult to compare these series because of differences in the patient populations, operative decompressive procedures, degrees of slip and spinal instability, grading of results, and levels of the spine at which the operation was done; therefore, the indications for concomitant arthrodesis with decompressive laminectomy in the operative management of patients who have degenerative lumbar spondylolisthesis and spinal stenosis have remained unclear. Nonetheless, the physiologic processes of the lumbar spine secondary to aging lead to lumbar spinal stenosis, including lumbar spondylolisthesis¹¹⁻¹². Back and leg pain may

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cause loss of functional capabilities, including activities of daily living; therefore, surgery for symptomatic lumbar spinal stenosis related to lumbar spondylolisthesis is becoming increasingly more common. Currently, minimally invasive surgery, not destabilizing and preserving posterior spinal elements, is popular in the field of not only joint surgery but also spine surgery. The surgical techniques for lumbar decompression have become progressively less invasive. Several techniques of minimally invasive decompressive surgery for the treatment of lumbar spinal stenosis and related conditions have been reported and their results have also been favorable.

Older lumbar laminectomy or laminotomy has been the optimal surgical procedure most often performed to treat leg pain related to lumbar spinal stenosis, affording wide decompression, but sometimes resulting in the destruction of surrounding tissues and postoperative low back pain secondary to paraspinal muscle denervation, muscle atrophy and iatrogenic biomechanical instability.

The surgical technique for spinous process osteotomy was initially described by Yong Hing and Kirkaldy-Willis in 197812 and some modifications have been made. In 1999, Weiner et al. described and discussed this technique for lumbar spinal stenosis13. We modified the original technique of spinous process osteotomy, (D-SPO), which can preserve posterior spinal elements, including paraspinal musculature, supra-/interspinous ligaments, pars interarticularis and facet joints, and have performed this procedure for patients with lumbar spinal stenosis associated with degenerative lumbar spondylolisthesis. The purpose of this study was to describe the surgical technique of D-SPO to preserve posterior spinal structure without requiring subsequent arthrodesis and to evaluate the outcomes and validity of this procedure for the treatment of mild degenerative lumbar spondylolisthesis with spinal stenosis. The outcomes were determined by measuring symptomatic relief, functional improvement, patient satisfaction, and perioperative and postoperative complications. Additionally, radiographic evaluation was performed.

I. Surgical Technique

An approximately 30-mm posterior-midline skin incision is made. The dorsolumbar fascia is incised to preserve the supraspinous ligamentous attachment to the fascia. When one level is decompressed, only one cephalad spinous process at the involved segment should be included. To obtain adequate and fair visualization, one level of the spinous process should be fully exposed with minimal incision. When L4/L5 spinal canal stenosis is decompressed, only the L4 spinous process should be located and exposed. The spinous process of the involved segments is located and paraspinal musculature, including the multifidus, is stripped unilaterally and minimally from its spinous and laminar attachments, care being taken not
to extend such subperiosteal dissection beyond the medial portion of the facet joint. Then, at the bottom of the spinous process, superficially to the junction of the lamina, the spinous process is osteotomized using a curved osteotome (Fig 1-A). A Cobb elevator is used to retract through the inter spinous notch on the contralateral side and against the multifidus ipsilaterally, which provides wide exposure of the segments to be decompressed with a Gelpy self-retained retractor and then, a full view of the interlaminar space is afforded. Then, stripping and retraction of the paraspinal musculature, including the multifidus, should be performed, taking care not to extend to the facet joint on the contralateral side (Fig 1-B).

Decompression through a limited laminotomy of the cephalad lamina is performed under excellent visualization and is added in a trumpeted undercutting technique to enhance decompression of the spinal canal, lateral recess and foraminal stenosis. Limited laminotomy is also performed on the caudal lamina. The ligamentum flavum is resected from cephalad to caudal, and from medial to lateral. Finally, complete decompression of the dural sac and nerve roots is confirmed. This limited laminotomy should be performed to preserve the facet joints and pars interarticularis completely. Additionally, the contralateral lamina should be retained as much as possible to contact with the osteotomized spinous process after the Gelpy self-retained retractor is taken off, while complete decompression is performed (Fig 1-C, D). The Gelpy self-retained retractor is taken off and the osteotomized spinous process resumes its native position and contacts with the contralateral retained lamina. The dorsolumbar fascia is resutured to the supraspinous ligament/dorsolumbar fascia complex with the osteotomized spinous process and finally ordinal skin sutures are made (Fig 1-E, F).

II. Materials and methods

Institutional review board approval was obtained for this retrospective review. A total of 32 patients met the inclusion criteria in this study: a preoperative clinical diagnosis of degenerative lumbar spondylolisthesis with lumbar spinal stenosis which had been unsuccessful treated with conservative treatment for at least 3 months; neurogenic claudication as defined by leg pain, limiting standing, walking or both; one level of degenerative spondylolisthesis demonstrated by a myelogram or magnetic resounance imaging; spinal stenosis only at the level of the spondylolisthesis. Degenerative lumbar spondylolisthesis was defined by the presence of sagittal vertebral translation ≥3 mm on a lateral standing radiograph. No developmental stenosis or incomplete decompression from previous surgery was involved in this study.

Before surgery, all patients were required to rate the pain in their back and legs subjectively and separately for severity on an analogue scale ranging from 0 to 10 points. This rating procedure was repeated at the
A. Only one cephalad spinous process at the involved segment is located. Unilateral exposure of the involved segment. The dorsolumbar fascia is incised off the midline to preserve the supraspinous ligamentous attachment to the fascia to expose one spinous process at the involved segment, taking care of not to extend subperiosteal dissection beyond the ipsilateral facet joint. After one spinous process is located and exposed, spinous process is osteotomized using a curved osteotome as close to the bottom of the spinous process as possible, superficially to the junction of the lamina.

B. Cobb elevator is used to retract the spinous process and contralateral paraspinal musculature through the inter spinous notch on the contralateral side and against the ipsilateral multifidus. Stripping and retraction of paraspinal musculature including multifidus should be taken care not to extend beyond the facet joint on the bilateral side. Then, Gelpy self-retaining retractor is placed and wide exposure of the segments to be decompressed is afforded.

C,D. Decompression by laminotomy and trumpeted undercutting technique is performed and the ligamentum flavum is resected. This laminotomy should be performed to preserve the facet joints and pars interarticularis completely.

E,F. Reconstruction and suture. Gelpy retractor is taken off and the osteotomized spinous process resumes its native position and contacts with, in many cases, the contralateral retained lamina. The dorsolumbar fascia is resutured to the supraspinous ligament/dorsolumbar fascia complex with the osteotomized spinous process and ordinary suture is performed.

most recent follow-up evaluation (mean, 30 months after operation). All patients underwent the current D-SPO between 2002 and 2006. All operations were performed by one of the authors (M.T.). All patients were available for a 2-year minimum follow-
Table 1 Clinical Outcome Measurement

<table>
<thead>
<tr>
<th>Back Pain</th>
<th>Leg Pain</th>
<th>Activity</th>
<th>Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>Occasional</td>
<td>None</td>
<td>Normal</td>
</tr>
<tr>
<td>Good</td>
<td>Mild</td>
<td>Mild</td>
<td>Normal</td>
</tr>
<tr>
<td>Fair</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Restricted</td>
</tr>
<tr>
<td>Poor</td>
<td>Severe</td>
<td>Severe</td>
<td>Restricted</td>
</tr>
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</table>

up. Two authors who were not involved in the care of the 32 patients reviewed all the charts and records. The records of these 32 patients (20 women and 12 men) were analyzed for radiographics, perioperative and immediate postoperative events, complications, a minimum 2-year follow-up clinical outcome, and satisfaction.

Operative records were analyzed to determine the number of levels operated on, estimated blood loss, blood transfusion requirements and length of operation. Additionally, perioperative and immediate postoperative events and complications related to operation were analyzed. The postoperative records were analyzed for the occurrence of any complications and blood transfusion requirements.

Clinical outcome measurements included the presence and severity of back pain and leg pain as compared with before surgery, the level of postoperative activity, and the need for pain control medications (Table 1). The outcome was considered excellent if the patient had occasional back pain and no leg pain, no restriction in his or her daily activities and no need for pain control medications. The outcome was considered good if the patient experienced improved symp-
toms as compared with before operation and no restriction in his or her daily activities, or did not require nonsteroidal anti-inflammatory medications for pain relief. The outcome was considered fair if the patient was restricted in daily activities because of moderate back or leg pain, or required non-steroidal anti-inflammatory medications for pain relief and resumption of daily activities. The outcome was considered poor if the patient had restrictions in daily activities because of either severe back or leg pain, or required narcotics for pain relief and resumption of daily activities.

Before operation, plain radiographs of the lumbosacral spine (including anteroposterior, left and right oblique, standing lateral, and standing lateral flexion extension) were taken for all patients. This series of radiographs was repeated at the most recent follow-up evaluation. The preoperative and follow-up radiographs were analyzed with respect to the extent of olisthesis, in millimeters, on the lateral radiographs; the total extent of olisthesis, in millimeters, on the lateral flexion-extension radiographs; the total extent of angular motion, in degrees, between the adjacent vertebral end-plates at the operative level as seen on the lateral
Table 2  Questionnaire

1) Do you have back pain? (Please choose one)
   I never have back pain
   I have occasional pain that does not compromise my activities
   I have mild pain that does not compromise my activities
   I have moderate pain that does not compromise my activities
   I have pain that is severe enough to limit my activities

2) Do you have leg pain? (Please choose one)
   I never have back pain
   I have occasional pain that does not compromise my activities
   I have mild pain that does not compromise my activities
   I have moderate pain that does not compromise my activities
   I have pain that is severe enough to limit my activities

3) Do you take medications to control your back or leg pain? (Please choose one)
   Yes, No

4) Can you do your desired daily activities? (Please choose one)
   I am able to do my daily activities as desired
   I have to modify my daily activities because of my back or leg pain
   I am unable to perform my daily activities because of my back or leg pain

5) If you have pain that limits your daily activities, how long were you pain-free after your surgery?

6) Please rate your overall satisfaction with your spine surgery. (Please choose one)
   I am very satisfied with my spine surgery
   I am satisfied with my spine surgery
   I am minimally satisfied with my spine surgery
   I am dissatisfied with my spine surgery

7) Which of the following expectations were satisfied with your back surgery? (you may choose all of the following)
   I have less pain
   I have to take less pain medication
   I have a better quality of life because of improved function

8) If you had the same symptoms and complaints again, as you did before your operation, would you choose to undergo the same operation again? (Please choose one)
   Yes, No

flexion-extension radiographs; and the height of the disc space at the operative level, on the standing lateral radiographs.

A self-administered questionnaire (Table 2) was sent to all patients to determine patient satisfaction with the outcome (including a four-point patient satisfaction measure (dissatisfied, minimally satisfied, satisfied, very satisfied) at the most recent follow-up evaluation (mean, 3.7 years after operation).

III. Results

The results of the current study are summarized in Table 3. The average age at op-
Table 3. Results in 32 Patients

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>32 (20 female, 12 male)</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>Average 67 yrs. (range: 50 to 86 yrs.)</td>
</tr>
<tr>
<td>Decompression level</td>
<td>L4/5 in 29, L3/4 in 2, L2/1 in 1</td>
</tr>
<tr>
<td>Operating time</td>
<td>48 min. (range: 30 to 68 min.)</td>
</tr>
<tr>
<td>No transfusion needed</td>
<td>32 (100%)</td>
</tr>
<tr>
<td>Estimated blood loss</td>
<td>40 ml (range: 22 to 90 ml)</td>
</tr>
<tr>
<td>Complications</td>
<td>2 dural tears, 2 postoperative transient neurological deficits, 1 postoperative spondylitis at the level one above the operative segment</td>
</tr>
</tbody>
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Table 4. Radiographic Findings

<table>
<thead>
<tr>
<th>Preop.</th>
<th>Postop.</th>
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</thead>
<tbody>
<tr>
<td>Mean height of disc space (mm)</td>
<td>6.8</td>
</tr>
<tr>
<td>Mean olisthesis (mm)</td>
<td>5.3</td>
</tr>
<tr>
<td>Mean olisthesis on flexion and extension (mm)</td>
<td>3.4</td>
</tr>
<tr>
<td>Mean angular motion (degrees)</td>
<td>9.6</td>
</tr>
</tbody>
</table>

Operation was 67 years, ranging from 50 to 86 years. The average follow-up period was 3.7 years, ranging from 2 to 5.5 years. The duration of patient symptoms before surgery averaged 2.7 years, ranging from 1 to 12 years. All patients had one level decompressed, L4/5 in 29, L3/4 in 2, L2/3 in 1. The average operating time was 48 minutes (30~68 min). The average estimated blood loss was 40 ml (22~90 ml). No blood transfusion was required in any patients. Perioperative complications occurred in 2 patients, both of which were dural tears as a result of Kerrison rongeur work and were repaired immediately without clinical sequelae. Postoperative complications occurred in 3 patients, 2 of which were transient neurological deficits, including loss of sensation and strength in the unilateral leg. These were attributed to partial root injury or compression of the spinal nerve during Kerrison rongeur work; however, both resolved uneventfully during an at least 6-month follow-up period. One was postoperative spondylitis one level above the involved segment without low back pain, which was resolved by using antibiotics; however, this was not attributed to the operation. Overall, perioperative and postoperative complications occurred in 5 patients (16%).

Before operation, the patient’s walking ability was approximately less than 100m in all patients and the reported walking tolerance ranged from 1 to 15 minutes (average, 8.2 min). At the initial follow-up evaluation (1 month after operation), all patients described their walking tolerance as more than 15 minutes. 6% (2/32) of the patients judged it to be 15~29 minutes; 19% (6/32) to be 30~44 minutes; 19% (6/32) to be 45~60 minutes; and 53% (17/32) to be unlimited. At the most recent follow-up evaluation
Fig 2  Patient example –A 50-year-old male–

A. Lateral radiograph showing mild degenerative lumbar spondylolisthesis (Grade D at L4/5 level, before operation.
B. Sagittal MRI before operation showing lumbar spondylolisthesis only at L4/5 level with spinal stenosis, before operation.
C. Computed tomography before operation at L4/5 level.
D. Computed tomography at the immediate postoperative period at L4/5 level. The spinous process of L4 was osteotomized.
E. Lateral radiograph showing no progression of listhesis at L4/5 level, at 2 years follow-up evaluation after operation.
F. Sagittal MRI showing satisfactory decompression of stenosis at 2 year follow-up evaluation after operation.
G. Computed Tomography at L4/5 level at 2 years follow-up evaluation, showing bony union between the osteotomized spinous process and the bottom of the retained lamina.

(mean, 30 months after operation), all patients described their walking tolerance as more than 15 minutes. 6% \( (2/32) \) of the patients judged it to be 15–29 minutes; 13% \( (4/32) \) to be 30–44 minutes; 19% \( (6/32) \) to be 45–60 minutes; 63% \( (20/32) \) to be unlimited. After surgery, the patient’s walking abili-
ty increased to over 1000m in all patients. Postoperatively, no patients still had neurogenic claudication. Clinical outcome analysis of the 32 patients demonstrated that 72% \( (24/32) \) had excellent results and 28% \( (8/32) \) had good results at the initial follow-up evaluation, and 78%
(25/32) had excellent results and 22% (7/32) had good results at the most recent follow-up evaluation. No patients had fair or poor results at both follow-up evaluations. In all patients, low back pain and leg pain, numbness or heaviness improved, postoperatively. In terms of satisfaction, 78% (25/32) were very satisfied with their outcome, and 22% (7/32) were satisfied. No patients were minimally satisfied or dissatisfied. In the questionnaire, all patients (100%) stated that they would choose to undergo this procedure.

**Radiographic Findings**

Height of the disc space
Measurement of the height of the intervertebral disc space at the operative level, preoperatively and at the most recent follow-up evaluation, revealed no significant difference (6.8 and 7.0 mm).

**Olisthesis**

No patients had a significant increase in olisthesis (average, 5.3 to 5.4 mm) compared with the preoperative value, including changes occurring on flexion and extension (3.4 to 3.5 mm) compared with normal values, as seen on the preoperative and most recent follow-up radiographs.

**Angular motion**

There was no significant increase in angular motion on lateral flexion-extension radiographs compared with preoperative values (average, 9.6 to 9.8 degrees).

**Patient example**

This patient was a 50-year-old man with spondylolisthesis at L4/5 level (Fig 2-A, B, C). Before operation, he had bilateral severe leg pain neurogenic claudication. Preoperative low back pain was moderate. Preoperative leg pain was severe. Preoperative walking tolerance was less than 15 minutes and less than 100m. After surgery, at the initial follow-up evaluation, postoperative low back pain was occasional and leg pain had resolved. Postoperative walking tolerance was unlimited. The clinical outcome was excellent. Two years postoperatively, the clinical outcome was excellent and maintained (Fig 2-D, E, F, G).

**Discussion**

Decompression primarily relieves radicular symptoms and neurogenic claudication, whereas fusion primarily relieves back pain by eliminating instability. The goals for instrumentation are to promote fusion and to correct deformity. Fusion has a better long-term outcome than decompression alone. There is evidence that instrumentation improves the fusion rate but does not improve the clinical outcome in a relatively short-term follow-up; however, the outcome of pseudarthrosis cases deteriorates over time and solid fusion produces a better long-term outcome. The benefit of instrumentation comes with the price of higher postoperative morbidity and complications. Some studies have reported satisfactory results with decompression alone; however,
most of these previous reports for the treatment of degenerative lumbar spondylolisthesis used older lumbar laminectomy or laminectomy, which have been the optimal surgical procedures most often performed to treat leg pain related to lumbar spinal stenosis, affording wide decompression. However, they sometimes result in destruction of surrounding tissues and postoperative low back pain secondary to paraspinal muscle denervation, muscle atrophy and iatrogenic biomechanical instability\(^{12,17}\). Postoperative iatrogenic instability may lead to postoperative low back pain.

Currently, several techniques of minimally invasive decompressive surgery for the treatment of lumbar spinal stenosis have been reported and their results have also been favorable\(^{14-25}\).

In 1999, Weiner et al. described and discussed the technique for lumbar decompression using spinous process osteotomy, and the short-term outcomes of lumbar spinal stenosis\(^{18}\).

Unilateral approaches to the lumbar spine have also been shown to be effective in bilateral decompression of the neural elements\(^{16,19,20}\). These approaches have the theoretical advantage of minimizing tissue injury, thereby reducing the likelihood of an adverse surgical stress response, while maintaining the spine’s structural integrity and stability. They also lend themselves well to microscopic and endoscopic techniques, thereby further minimizing the extent of tissue disruption. In 1997, Foley et al.\(^{20}\) described and discussed microendoscopic decompression with endoscopic visualization for lumbar spine disorders and reported excellent clinical outcomes in addition to excellent decompression, while minimizing damage to surrounding tissues. In 1999, Weiner et al\(^{19}\), described and discussed microdecompression with microscopic visualization for lumbar spinal stenosis and reported excellent clinical outcomes in addition to excellent decompression, while minimizing damage to surrounding tissues; however, there are advantages and disadvantages with this kind of unilateral approach. Thereafter, a microendoscopic technique was applied for the treatment of lumbar spinal stenosis and some studies have reported favorable results\(^{21-23}\).

Although this study is limited in that it was not a randomized study with a control group, there are several advantages to the current D-SPO procedure, even compared with decompression and arthrodesis with or without instrumentation, or other minimally invasive surgical techniques, including microdecompression with microscopic or endoscopic visualization.

**Incision**

In the current D-SPO, a midline incision of approximately 30 mm is required. Only one spinous process at the involved level should be included. The incision for microdecompression with a microscope or endoscope is reported to be smaller (approximately 18–20 mm)\(^{12,23}\); however, an incision of approxi-
mately 30 mm in the current D-SPO is considered small enough for complete and safe completion.

**Technique and instruments**

Microscopic and endoscopic techniques require specific instruments and are technically demanding. Working through a small operative widow at a significant angle to address the contralateral side requires extensive knowledge of lumbar microanatomy and considerable experience of both Kerrison rongeur and microscopy or endoscopy\(^{15,21-23,26,27}\). The current D-SPO does not require any specific instruments nor does it require specific techniques. Additionally, the current technique is technically straightforward.

**Visualization and decompression**

In degenerative lumbar disorder, the majority of spinal nerve compression occurs at the level of the interlaminar window. Spinous process osteotomy affords excellent visualization of the interlaminar window, comparable with that of older laminectomy and laminotomy. The interlaminar window is used to afford limited facetectomy, pars resection and resection of the ligamentum flavum through limited laminotomy, while adequate decompression can be achieved using undercutting techniques to allow trumpeted retraction of the area within the spinal canal and the suarticular and foraminal zones to achieve decompression completely, preserving the residual lamina, pars, facet and facet joint capsule.

For microdecompression using microscopy, working through a small operative window at a significant angle to address the contralateral side requires extensive knowledge of lumbar microanatomy\(^ {15}\) and there are some limitations on visualization of the contralateral suarticular and foraminal zones. For microdecompression with an endoscope, some authors have reported a disadvantage of poor visualization and thereby, difficulty in handling the instruments\(^ {21-29}\). Furthermore, most studies on microdecompression techniques with an endoscope have documented an increased number of perioperative complications of dural tears due to poor visualization\(^ {25-29}\). They also demonstrated difficulty with primary repair, working through a small operative window, which resulted in the need for complete laminectomy. Three dural tears occurred in our cases but we experienced no difficulty in primary repair. Excellent visualization is one of the major advantages of D-SPO, while minimizing incision and tissue trauma.

**Paraspinal musculature and postoperative instability**

The current D-SPO with maintenance of the multifidus attachment mechanically limits ipsilateral retraction, generally to the level of the medial facet border, while limited elevation or retraction of the contralateral multifidus is performed.

The microdecompression technique with microscopy or endoscopy limits ipsilateral re-
traction of the multifidus to the level of the medial facet border and no elevation or retraction is performed, minimizing the risk of iatrogenic muscular trauma; therefore, this technique may be less invasive than D-SPO. With the current D-SPO or microdecompression technique with microscopy or endoscopy, preservation of bony stability can be achieved with limited facetectomy and resection of the pars interarticularis. Additionally, as the involved supra-/interspinous ligaments are completely preserved, the biomechanical milieu may not be altered.

**Low back pain**

Kallakuri et al\(^\text{28}\), described that numerous fine nerve fibers and some small bundles were demonstrated in both the dura and longitudinal ligaments by an immunocytochemical study of nerve fibers in the lumbar spinal dura and longitudinal ligaments in New Zealand white rabbits, and the results clearly demonstrated extensive distribution of nerve fibers in the dura and longitudinal ligaments. They concluded that the presence of a significant number of putative nociceptive fibers supports a possible role of these structures as a source of low back pain and radicular pain. Interestingly, although all our patients underwent the current decompressive surgery alone without fusion, the preoperative low back pain improved postoperatively and the condition was maintained. It was supposed that adequate decompression of the dura and nerve roots alone by the current technique is an important factor resulting in postoperative improvement of low back pain. Additionally, as the current D-SPO is carried out by minimized destruction of the uninvolved structures, the biomechanical milieu is only minimally altered. These superior biomechanical advantages are all beneficial for not creating a source of postoperative low back pain. Additionally, Gejo et al\(^\text{29}\), reported that, during posterior lumbar spine surgery, 5-minute retraction release after 1 hour or after 40 minutes of retraction was effective in preventing severe back muscle injury after surgery. Shorter operating time (average: 40 minutes) and minimized incision and tissue trauma using the current procedure are beneficial for minimizing back muscle injury and may avoid postoperative low back pain.

**Clinical outcomes and patient satisfaction**

In the current study, 72% (24/32) of the patients had excellent results and 28% (8/32) had good results at the initial follow-up evaluation, and 78% (25/32) had excellent results and 22% (7/32) had good results at the most recent follow-up evaluation. No patients had fair or poor results at both follow-up evaluations. Ragab et al\(^\text{30}\), demonstrated that 108 (91%) of 118 patients of 70 years of age (range, 70–101 years) or older undergoing decompression with arthrodesis could have excellent or good results. Sanderson and Wood\(^\text{12}\) reported excellent or good results in 81% of patients of 65 years of age or older during an average follow-up period...
Indications and Limitations

The current D-SPD without stabilization is indicated in the majority of patients with a single level of mild degenerative lumbar spondylolisthesis with spinal stenosis. In the majority of patients, 72% (129/179) were satisfied with their outcome and 26% (76/291) were satisfied, and 13% (66/477) were dissatisfied or not followed up evaluation. No patients were minimally satisfied or dissatisfied.

References


