Results of Instrumented Fusion in Cases of Symptomatic Adult Degenerative Lumbar Spondylolisthesis with Canal Stenosis Previously Treated with Decompression Alone

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ABSTRACT

During a 5 year period, the authors performed instrumented transpedicular fusion with posterolateral fusion in cases with symptomatic adult degenerative spondylolisthesis with canal stenosis previously treated with decompression alone. There were 14 females and 11 males, with a mean age of 53 years. Twelve patients had Meyerding grade I and grade II in the remainder. All patients selected for surgery had failed conservative measures with symptoms including mainly back pain, leg pain and neurogenic claudication . All patients had neurological examination and radiological investigations including dynamic plain radiographs, CT scan and MRI with a clinical and radiographic follow up period for about 9.5 months. The surgical procedure was described in details, and lateral fusion was performed using bone graft harvested from the posterior part of the iliac crest. Fusion was performed at one level in 19, two levels in 5 and three levels in one patient.Operated segments included L45 level in all cases (100%), L34 in 4 cases (16%), L23 in one case (4%) and L5S1 in one case (4%).Excellent outcome was reported as regard leg pain and neurogenic claudication, (94%) and 90% respectively. Good result of back pain (84%) while fair outcome in leg numbness and weakness (50% and 40%). To conclude, the ideal procedure for cases of canal stenosis with degenerative spondylolisthesis is decompression with istrumented lateral fusion via transpedicular screws. Even in patients who failed improvement after decompression alone, they can benefit markedly from instrumented lateral fusion.

Key words: *Lumber spine. Stenosis. Spondylolisthesis. Fusion. Transpedicular fixation.*

INTRODUCTION

Degenerative spondylolisthesis is described as the anterior translation of one vertebral body over another adjacent one in absence of a defect of pars interarticularis.

When this is combined with canal stenosis patient complaints include lower back pain, radicular pain and /or symptoms of neurogenic claudication. Fixed neurologic deficits may be absent or subtle in the form of reflex changes and/or mild bowel or bladder difficulties. Significant fixed motor paralysis and/or sphincteric troubles are less common. The main goal of treatment in spinal stenosis with degenerative spondylolisthesis is decompression of both exiting and traversing nerve roots. The role of arthrodesis, with or without instrumentation was controversial.[23]

In a review of 290 patients who underwent decompression laminectomy alone the reported outcome was excellent in 69%, good in 13%, fair in 12%, and poor in 6%.[24] A study conducted by Herkowitz and Kurz[7] compared the results of decompression alone versus decompression and intertansverse arthrodesis. Only 44%of patients with decompression without fusion reported satisfactory outcome compared with 96% of patients reporting the same outcome who received decompression plus fusion.

The analysis of Mardjetco and Colleagues[25] demonstrated that patient

outcome was significantly better when concomitant arthrodesis was performed with decompression with less liability to slip progression.

Instrumented arthrodesis has been shown to produce higher fusion rates, than non instrumented arthrdesis. Patients undergoing instrumented arthrodesis demonstrated an 87% fusion rate while those patients undergoing a non instrumented arthrodesis had a 45% fusion rate.[26] Based on the current literature, patients who received instrumentation at the same time as arthrodesis will have a higher fusion rate with better long term clinical effects in the treatment of degenerative spondylolisthesis combined with canal stenosis.[23]

In this study, the authors selected 25 cases of degenerative adult lumbar spondylolisthesis with canal stenosis who were previously treated with decompressive laminectomy alone and they had fair or poor result after surgery. Lateral fusion was performed together with instrumentation via transpedicular fixation systems.

Clinical Material and Methods

Patient population

A total of 25 patients with degenerative lumbar spondylolisthesis who were previously treated with decompressive laminectomy alone and they had fair or poor result or become worse after surgery were selected in this study.

They underwent transpedicular screw fixation with posterolateral lumbar fusion by the author between 2000 and 2005.

None of our patients had preoperative secondary gain issues, including claims for worker's compensation or litigations following accidents.

All patients had radiographic evidence of spondylolisthesis which was Meyerding Grade I in 12 patients and Grade II in 13, with evidence of the previous decompressive laminectomy.

All patients selected for this study had no improvement, or became worse after decompressive surgery. All of them had also failed conservative treatment which included bed rest, courses of anti-inflammatory medications, physiotherapy, external bracing and five of them had an epidural steroid injection.

Symptoms consisted of back, buttock and posterior thigh cloudication pain or lumbosacral radiculopathy.

Leg weakness and bowel and bladder dysfunction were rare symptoms.

Radiographic studies

All patients obtained preoperative radiographs with flexion and extension views and imaging studies to evaluate both neutral compression, pedicle anatomy, progressive slippage in relation to the previous laminectomy radiographs, and the previous bony work done during the decompressive laminectomy, meaning CT scan and MRI with and without contrast.

Radiographs were obtained also postoperatively at regular intervals until fusion was demonstrated. The mean radiographic follow up period was 9.5 months.

Fusion was defined as the presence of bilateral continuous trabecular bone between the fused segments lateral to the instrumentation set.

Operative technique

Under general endotracheal anasthesia and the patient in the supine position the usual exposure was carried out with two levels above and below the intended level through a midline lumbar incision preparation of the posterior iliac crest area was done on the RT side. Care was taken during muscle dissection because of the previous decompressive laminectomy.

Excision of ugly scars was performed in few cases. Dissection was continued laterally over the facets till exposure of the transverse processes using electrocautery.

At this stage the pedicle was identified at the point of intersection of a line drawn through the axial plane of the transverse process and the sagittal plane through the lateral superior facet. The location site of the pedicle was confirmed by using both anteroposterior and lateral fluoroscopy.

Once the entry point was determined the bone is decorticated and the oul was advanced manually through the cancellous center of the pedicle into the vertebral body and fluoroscopic guidance. The rostrocaudal orientation was determined by lateral fluoroscopy, maintaining the trajectory parallel to the end plate.

An approximately sized pedicle screw was advanced into the pedicle and body along the predetermined trajectory. We used the top loading pedicle screws and rods in all cases, and a cross link was added in some cases of suspected rotational instability.

At this stage the rod was matched and bent, and then attached to the screws. At this point the distractor was applied between the screws and a 3 mm distraction was performed followed by tightening the screws while the distractor was applied. The distraction technique was done on both sides one after the other followed by final tightening of the screws using a torque wrench. Distraction technique aims at foraminal widening, opining the stenotic lateral recesses and facilitating the process of nerve root decompression -when need- as the compressed root becomes more mobile in a roomy lateral recess, and eliminating also the cause of far-out lateral syndrome. Further decompression was required in some cases (10 cases) in whom previous decompressive laminectomy was not sufficient, or further level of stenosis were found in the preoperative radiographs.

In these cases complete facetectomy of the fixed level was performed, with bilateral foraminotomy exposing first previously non operated tissues without scar, which makes identification of intact dural margins easier and safer.

Posterolateral fusion technique was then performed. The transverse processes were decorticated and the bone harvested from the posterior part of the iliac crest through a separate skin incision was used. The pieces of bone were packed over the decorticated surfaces, after soft tissues have been removed adequately.

Demineralized bone matrix polymer was used in some cases of osteoperosis to supplement the auto graft.

Sub facial drains were placed before multilayer wound closure.

RESULTS

Twenty five cases were included in this study; there were 14 female and 11 male patients with a mean age of 53 years (range 36-62 years).

Regarding the preoperative clinical manifestations, table 1 shows the preoperative symptoms, mean duration, and walking aids.

Table 1. Summary of preoperative symptoms, mean duration and walking aids

Parameters	No	%
* Symptoms (No. of cases)		
- LBP.	19	76%
- Leg pain	16	64%
- Neurogenic claudication	10	40%
- Subjective numbness	8	32%
- subjective weakness	5	20%
* Mean duration of symptoms (months) after surgery		
- LBP	20	80%
- Leg pain	16	64%
- claudication	18	72%
* Walking aids (No. of cases)		
- none	17	68%
- cane	5	20%
- crutches	3	12%
- wheel chair	-	-

A total of 114 screws were placed. Instrumented fusion was reformed at one level in 19, two levels in 5 and three levels in one patient.

Operated segments included L 45 in all cases (100%), L34 in 4 cases (16%) L23 in one case (4%) and L551 in one case (4%).

Data for duration of hospital stay and external bracing are presented in table 2, there was no statistically significant difference when comparing patients with one or more than one operated levels. Increased blood loss and longer operation time was noticed in cases with more than one fixed segment.

Table 2. summary of duration of hospital stay and external bracing

Variables	No. of patients	Duration of study (Days)	Duration of bracing (wks)	%
All patients	25			
1 level	19	5.1	7	76%
2 levels	5	6	10	20%
3 levels	1	6.7	10.8	4%

Pain outcome

Table 3 summarizes patient-reported changes in back and leg pain, numbness, weakness and neurogenic claudication . Patient outcome was graded as excellent if the patient had no back or leg pain with unlimited walking. A good outcome indicated good improvement of back and /or leg pain but with residual unlimiting pains. A fair outcome indicated improved back and/or leg pains but with pains leading to modification of daily activities. A poor outcome denoted no improvement or worsening of preoperative symptoms.

Table 3. Summary of follow up results

Symptoms	Preoperative incidence No. of patients		Post-operative status No. of patients			
	Yes	No	None	Improved	Same	Worse
- Back pain	19	6	7(37%)	9(47%)	3(16%)	-
- Leg pain	16	9	12(75%)	3(19%)	1(6%)	-
- Leg numbness	8	17	2(25%)	2(25%)	3(38%)	1(12%)
- Leg weakness	5	20	1(20%)	1(28%)	3(60%)	-
- Neurogenic claudication	10	15	7(70%)	2(20%)	1(10%)	-

Subjective improvement in back pain was reported by 16 (84%) out of 19 patients. Leg pain improved in 15 (94%) out of 16 patients, Neurogenic claudication improved in 9(90%) out of 10 patients while leg numbness and leg weakness showed less rate of improvement, i.e. 50% and 40% respectively.

Radiographic outcome

Assessment of distraction of the listhetic space was first done intra-operative by lateral fluoroscopic view after final tightening of the fixation system. Distraction was evidenced as increased posterior disc height for one to three mm than in the preoperative lateral view radiographs. During follow up period this distance of distraction was also followed together with the routine follow up for fusion. Fusion was defined strictly as the presence of bilateral continuous trabecular bone between fixed segments. Results of fusion are presented in table (4). Sufficient radiographic evidence of fusion was evident in 22 (88%) of patient. The remaining three patients were osteoporotic more than 53 years old. They did not fulfill fusion criteria but had solid constructs. Data also showed no evidence of progressive anterior slippage in any of the cases during the period of follow up.

Table 4. Summary of fusion results

Group	No. of patients	Evidence of fusion No. of patients	%
All patients	25	22	88%
Sex			
male	11	10	91%
female	14	12	86%
Age			
< 53 y	12	12	100%
> 53 y	13	10	77%
degree of listhesis			
1st D.	12	10	83%
2nd D.	13	12	92%
Smoking			
smokers	7	7	100%
Non smokers	18	15	83%

Complications

Complications occurred in 5 cases (20%) of the 25 cases included in this study. Complications and rate of incidence are listed in table 5.

Table 5. Summary of postoperative complications

Complication	No. of patients	%
- Wound infection	2	8%
- Dural tear and CSF leak	1	4%
- Epidural hematoma	1	4%
- DVT	1	4%

There was no vascular injury from screw placement or any deaths as a result of surgery. We had 2 cases of wound infection; one of them had a superficial infection which required oral antibiotics with repeated dressing. The other patient was febrile and deeper infection which required a course of parenteral antibiotics according to culture and sensitivity test without removal of the fixation system. One patient had inaccible dural tear and she has CSF leak from the wound that required insertion of a lumber drain for 5 days till complete healing of the wound. We had a case of epidural hematoma that required re-exploration and evacuation on the 3rd post operative day.

FiG.1. Preoperative AP view of one of the patients showing the previous decompressive laminectomy of L4.

FiG.2. Preoperative lateral view of the same patient in Fig.1 showing degenerative spondylolisthesis L45.

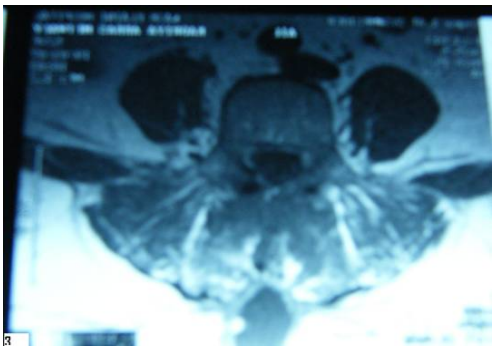

FiG.3. Axial MRI image of the same patient in fig.1 showing adequate canal decompression while the patient still complaining.

FiG.4. Postoperative lateral view showing the pedicle screw fixation system done for the same Patient in fig.1.

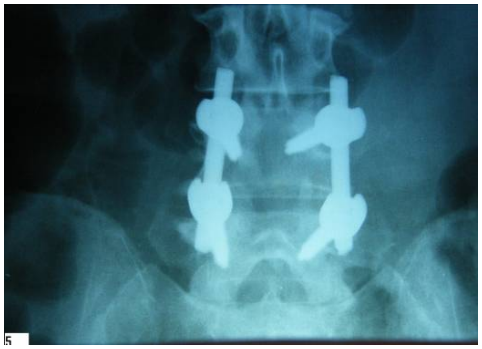

FiG.5. Postoperative AP view showing the top loading fixation system using rods for the same patient in fig.1.

FiG.6. Preoperative plain lateral view for another patient showing L34 degenerative spondylolisthesis.

FiG.7. AP view of the same patient in fig.6 showing the decompression site at L34.

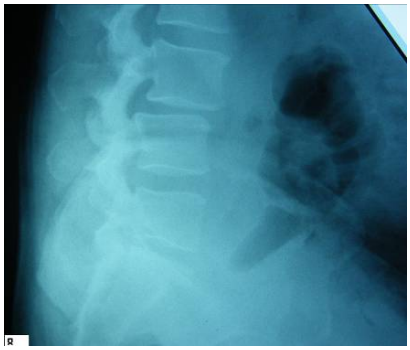

FiG.8. Lateral view in flexion showing more Displacement at L34 level of the same patient.

FiG.9. Postoperative lateral view showing L34 transpedicular fixation with screws and rods for patient in fig.6.

FiG.10. Postoperative AP view for the same patient in fig.6 with the lateral bony fusion evident on both sides of the rods.

DISCUSSION

Several authors have reported the results of studies that demonstrate a beneficial effect when posterior lumbar fusion (PLF) is conducted following decompression in patients with lumbar stenosis associated with degenerative spondylolisthesis. Nerkowitz and Kurz[7] presented a series of 50 patients with varying degrees of degenerative spondylolisthesis and stenosis who were treated with decompressive surgery. Patients were alternately assigned to decompression alone (25) or decompression combined with noninstrumented PLF (25). At a mean follow up-interval of 3 years, 96% of

the patients treated with a fusion/ decompression reported an excellent or good outcome compared with 44% of those treated with decompression alone. Patients who underwent fusion also reported statistically significant less back and leg pain. Poor results were generally associated with progression of spinal deformity in the decompression alone group. Lombard, et al.[12] published a retrospective review of 47 patients with lumbar stenosis and degenerative spondylolisthesis who underwent decompression. They divided patients into three treatment groups: decompression with factectomy, decompression with preservation of the facet joints, and decompression combined with PLF. The decompression/facetectomy group had the worst outcomes; only 33% reported good or excellent results. In the decompression/ preserved facet joint group 80% reported good or excellent results. In the decompression/PLF group 90% reported good or excellent results. Feffer, etal.[5] And Postacchini and colleagues[14] described their results obtained in smaller series of patients with stenosis and degenerative spondylolisthesis. Again, the decompression fusion group reported a higher incidence of good or excellent outcome than the decompression-alone group. Katz et al.,[9] reported the results of a study involving 272 patients with lumbar stenosis and degenerative spondylolisthesis. Seventy-one percent were treated with laminectomy alone while 29% were treated with instrumented or non-instrumented fusion in addition to decompression. They observed that fusion treated patients reported better outcomes as regard back pain, leg pain and walk tolerance. Katz, et al.[10] reported a similar benefit of adding fusion in patients with lumbar stenosis and degenerative spondylolisthesis. Further supporting evidence for the addition of fusion to decompression in patients with stenosis and spondylolisthesis is derived from a number of case series reporting excellent results when using various lumbar fusion techniques for example, Zhao et al[16] and Park et al.,[27] who reported 90% and 85% good and excellent result in the fusion group respectively. Bednar[1] reviewed a series of 54 patients with degenerative spondylolisthesis and stenosis who underwent decompressive surgery and fusion using spinal instrumentation. Over all 77% of patients reported substantial benefit from surgery. Booth etal.,[2] published a long-term follow up study of 41 patients who underwent decompression and PLF for degenerative spondylolisthesis and stenosis. Eighty-three percent of patients were satisfied with the results of surgery and 86% reported significant functional improvement. Similarly Nork and colleagues [13] reported 93% improvement, with statistically significant improvement in their ability to perform heavy and light activities, back and leg pains, sitting, walking and sleeping.

Several authors have published their experience in the surgical management of patients with stenosis and spondylolisthesis treated with decompression without fusion. Kinoshita et al.[11] reported 78% good or excellent results in a series of 51 patients. Herron and Mangelsdorf[8] reported improvement in 20 patients out of 24 at the 4 month follow up interval. In contrast Dall and Rowe [4] reported poor results in 17 patients treated with decompression alone.

A number of authors have examined the role of pedicle screw fixation as an adjunct to PLF following decompression in this patient population. Bridwell, etal.,[3] reported a study of 44 patients with stenosis and degenerative spondylolisthesis who

were randomized into one of three groups: decompression alone (group I) decompression and non instrumented fusion (group II) and decompression and instrumented fusion (group III).

The authors noted improved radiographic and functional outcomes among patients in group III compared with the other two treatment groups, which support the role of instrumented fusion for patients undergoing decompression for stenosis with degenerative spondylolisthesis. Fischground and colleagues [6] reported a clinical trial of 68 patients with stenosis and degenerative spondylolisthesis who were randomized into two groups: decompression and PLF in one group and decompression and PLF supplemented with pedicle screw fixation in the other. Fusion status was assessed using plain and dynamic radiographs.

The patients treated with pedicle screw fixation had a statistically significant higher fusion rate (83%) than the non-instrumented group (45%). Both groups demonstrated significant improvement for both back and leg pains.

Thomsen et al.[15] reported a trial of 130 patients who underwent lumbar fusion for degenerative spondylolisthesis with stenosis. Patients were randomized to instrumented (pedicle screw fixation) and non instrumented PLF. The decompression fusion group patients who underwent instrumented PLF scored better than those with non instrumented PLF.

Several other smaller studies provide evidence supporting the use of pedicle screw fixation as an adjunct to fusion.[18,19,21,28] Kimura et al.,[29] reported the results of a retrospective review of 57 patients with degenerative lumbar spondylolisthesis and stenosis treated with decompression and fusion with and without pedicle screw instrumentation. They reported approximately similar clinical outcomes but noted that patients with excessive motion or kyphosis associated with spondylolisthesis did better with pedicle screw fixation.

Kawakami et al.[30] found that patients with preoperative lumbar kyphosis who underwent pedicle screw instrumentation_ augmented fusion did better than patients who were treated with non instrumented fusion.

Mochida,etal.,[31] found also that the addition of rigid pedicle screw fixation improved outcome compared with their controls of non instrumented fusion, supporting the use of pedicle screw fixation in patients undergoing decompression and PLF for stenosis associated with spondylolisthesis and either kyphosis or instability. Addition of distraction during instrumented fusion of spondylolisthesis will help elimination of the possible causes of radiculopathy including rotational component and the far-out lateral syndrome rendering the lateral recesses more roomy making foraminotomy unnecessary in those previously operated patients. [17, 20, 22]

In this study, it was clear that patients who failed improvement after decompression alone showed excellent results regarding leg pain and claudication pain and a good result regarding back pain after instrumented lateral fusion.

Conclusion

The majority of evidence and our study outcomes favors the performance of instrumented posterolateral fusion together with decompression in patients with canal stenosis and degenerative spondylolisthesis. Even in patients who failed improvement after decompression alone, they can benefit markedly from instrumented lateral fusion with addition of distraction during fixation for lateral

recess opening and for elimination of far-out lateral syndrome.

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