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Original Article

The Efficacy of Unilateral Approach for Bilateral Decompression and Fusion in Spinal Stenosis with Segmental Instability

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Abstract

Objective: **To evaluate the efficacy of the unilateral approach for bilateral decompression and fusion (UBD & fusion) in spinal stenosis with segmental instability**

Methods: **Retrospective review of patients underwent surgery with unilateral approach for bilateral decompression and fusion during April 2010 and April 2012 was performed. Fifty one patients were included in the study. The visual analog scale (VAS), Neurogenic Claudication Outcome score (NCS), and Prolo Functional and Economic Scales (Prolo score) were used to evaluate all patients preoperatively and at 1-year follow-up. The success of the intervetebral fusion was assessed at 1 year after index surgery. Complications, including adjacent segmental degeneration and instrument failure, were recorded in the postoperative assessment.**

Results: **Fifty one patients who underwent unilateral approach for bilateral decompression and fusion achieved favorable outcome. The VAS, NCS and Prolo score had significantly improved at 1- year follow-up and the fusion rate was 100 percent with no surgical complication.**

Conclusions: **Favorable results from the novel technique "Unilateral Approach for Bilateral Decompression and Fusion" were found. This technique gives an adequate bilateral nerve roots decompression with high successful spinal fusion rate.**

Keywords: **Transpedicular screw fixation, transforaminal lumbar interbody fusion, unilateral Approach for Bilateral Decompression & Fusion (UBD & Fusion)**

INTRODUCTION

Degenerative lumbar disorders are commonly found in the elderly. The disorders feature lumbar disc herniation, lumbar spinal stenosis, spondylolisthesis and segmental instability[9]. Patients are presented with back pain or leg pain together with neurogenic claudication[6,8,9]. When surgical treatment is indicated, decompression of spinal canal and fusion are key procedures. Many surgical techniques have been proposed[1,3,6,9,10].

Unilateral approach for bilateral decompression technique was developed from microsurgical fenestration by McCulloch[9]. This technique needs a laminectomy approach only from one side to perform a bilateral nerve root decompression (Figure 1). Many authors reported high success rate of this

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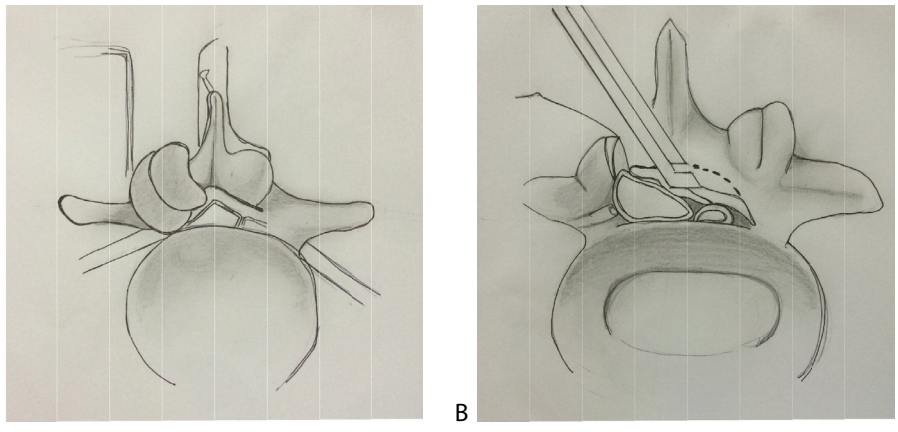

Figure 1 Unilateral approach to more pronounce symptoms side (A); Decompression under microscopic assist for contralateral side (B)

technique[6,8,9,13,14].

Degenerative lumbar spine does not bring only neural compressive symptoms but also segmental instability which needs spinal fusion along with decompression[12,14]. The authors have developed novel less invasive technique for decompress nerve roots, together with stabilizing the spine by an "Unilateral Approach for Bilateral Decompression and Fusion (UBD & Fusion)". The fusion method in this technique is transforaminal lumbar interbody fusion (TLIF).

In this study, we reported an outcome of this technique. The unilateral approach for bilateral decompression and fusion (UBD & Fusion) techniques were performed in patients with lumbar spinal stenosis and spondylolisthesis. The outcomes, including visual analog scale (VAS), Neurogenic Claudication Outcome Score (NCS), Prolo functional and economic scales (Prolo score), were collected. The evidence of interbody fusions was evaluated by plain radiograph in both static and dynamic views. We compared these preoperative parameters with the postoperative results at one year.

Materials and Methods

Patient characteristics and patient selections

Between April 2010 and April 2012, 51 patients (22 males and 29 females) (Table 1) with degenerative lumbar spinal stenosis and spondylolisthesis were treated with unilateral approach for bilateral decompression and fusion by a single surgeon (Tangviriyapaiboon T.) at the Prasart Neurological Institute Hospital, Bangkok, Thailand. The following criteria were used to select patients:

1. Diagnosis of degenerative lumbar spinal stenosis with spondylolisthesis;

2. Patients with back pain or leg pain with neurogenic claudication;

Table 1 Basic characteristic of patients

	N (%)
Gender	
Male	22 (43.14%)
Female	29 (46.86%)
Total	51
Age in years on admission date	
30 - 39	5 (9.80%)
40 - 49	7 (13.73%)
50 - 59	14 (27.45%)
60 - 69	19 (37.26%)
70 - 79	6 (11.76%)
Chief complaint	
Back pain	39 (76.47%)
Leg pain	12 (23.53%)
Level of unilateral approach for bilateral decompression	
L2-3	12 (12.63%)
L3-4	28 (29.47%)
L4-5	44 (46.32%)
L5-S1	11 (11.58%)
Total	95 levels
Level of transforaminal lumbar interbody fusion	
L2-3	6 (10.53%)
L3-4	13 (22.80%)
L4-5	31 (54.39%)
L5-S1	7 (12.28%)
Total	**57 levels**

Table 2 Summary of the Neurogenic Claudication Outcome Score (NCS)

1. How far can you walk before having to stop and rest?			
a) <100 meters	b) between 100 meters and 1 /2 kilometers	c) between 1/2 and 1 kilometers	d) >1 kilometers
2. How long can you stand still before having to sit down?			
a) <5 minutes	b) 5-15 minutes	c) 15-45 minutes	d) as long as I please
3. Once your symptoms arise, you have (rank each) back pain, leg pain, numbness/tingling, heaviness/weakness			
a) severe	b) moderate	c) mild	d) none
4. The symptoms affect the following activities (rank each): sports or activities, household or odd jobs, walking, standing, sitting, sex life.			
a) severely	b) moderately	c) mildly	d) not at all
5. How long must you rest before the symptoms resolve?			
a) >10 minutes	b) 5 - 10 minutes	c) <5 minutes	
6. How frequently do you take pain medicine for these symptoms?			
a) frequently	b) daily	c) occasionally	d) never
7. How frequently do you see a doctor for these symptoms?			
a) frequently	b) monthly	c) rarely	d) never
8. Rank your pain on the following scale:			
0———1———2———3———4———5———6———7———8———9———10			
no pain			worst pain

* The score is calculated by adding: çaé answers = 0 points; çbé answers = 2 points; çcé answers = 4 points; çdé answers = 6 points plus the pain scale added as (10 - x), where x is the number on the pain scale chosen by the patient.

3. Unilateral approach for bilateral decompression;

4. At least 1-year follow-up period.

The mean age was 57 years (SD = 11.77). The indication for surgery was intractable back pain or leg pain with neurogenic claudication unresolved after conservative treatment by medication and physiotherapy. Thirty-nine patients presented with back pain while 12 patients had leg pain. The mean preoperative pain score was 7.6 (range 5-10). All patients had neurogenic claudication with a mean claudication distance of 129.41 meters (range 20-200 meters). The mean tolerable standing time was 15.88 minutes (range 5-45 minutes).

Clinical assessment

Patients with spondylolisthesis from causes other than degenerative or previous lumbar surgery were excluded. Retrospective reviews of hospital charts were conducted to access age, gender, preoperative symptomatology, clinical presentations, VAS, diagnosis, preoperative clinical symptopms were evaluated by NCS (Table 2) and Prolo functional and economic scales (Table 3). Operative records were reviewed for level of surgery. The results of surgery (Neurogenic Claudication Outcome Score and Prolo functional and economic scales) were obtained at 1-year follow-up.

Table 3 Summary of the Prolo Functional and Economic Scales

Score	Criteria
Functional status	
1	total incapacity (worse)
2	moderate-to-severe daily pain (no change)
3	low level of daily pain (improved)
4	occasional or episodic pain
5	no pain
Economic Status	
1	complete invalid (worse)
2	no gainful occupation (including housework or retirement activities)
3	working/active but not at premorbid level
4	working/active at previous level with limitation
5	working/active at previous level without restriction

Excellent outcome score 9-10, Good outcome score 7-8, Fair outcome score 5-6, Poor out score ≤ 4

Radiographic assessment

The interbody fusions were evaluated at 1-year follow-up. The successful fusion was defined by these criteria; absence of radiolucency halo around the screws, presence of bilateral continuous trabecular bone bridge between the fused segments in anteroposterior plain film, and lack of motion in flexion-extension film[1,2,5]. In plain radiograph, the adjacent segment degeneration was also considered by following findings; presence of anterolisthesis or retrolisthesis in adjacent level more than 3 mm and decreased intervertebral disc height more than 3 mm[7].

Statistical assessments

The difference between preoperative and 1-year postoperative symptoms were evaluated in term of VAS, NCS and Prolo functional and economic scales with paired t test, a *P* value of < 0.05 was considered to be significant.

Surgical technique

After general anesthesia, the patient was placed in a prone position on a radiolucent table. The target level was verified by fluoroscopy. The planned incision was marked between target pedicles in line with paravertebral muscles. If more than two levels were operated, we preferred a midline incision in this situation. If paravertebral incision was used, dissection was carried out through lumbodorsal fascia and paravertebral muscle into laminae in the same line with incision. But in midline incision, the lumbodorsal fascia was incised closed to the spinous process, leaving the interspinous ligaments intact; and the paraspinous muscle was elevated from the spinous processes, laminae, and the facet joints. After reach laminae and facet joints, the unilateral hemilaminectomy was then performed at the appropriate levels under microscopy. The ligamentum flavum is completely removed. We tilted the microscope at this time for better visualization of space under spinous processes and contralateral laminae. The spinous process and ligamentum flavum were removed by undercutting technique. At this point, the contralateral nerve roots were clearly seen. Decompression of contralateral nerve roots was performed. Total fecetectomy and discectomy joint were performed for TLIF procedure. The autologous local bone graft or PEEK cage with autologous bone graft was introduced to intervertebral space. The pedicle screws were placed in the standard fashion. The same sequences of dissection to contralateral laminae and facet joints were repeated just only for pedicle screw insertion and posterior bone grafting. The posterior instrumentation was then tightened before closing suture of paraspinal muscle and skin were made[15].

RESULTS

We included 51 cases of patients who underwent transpedicular screws insertion with Unilateral Approach for Bilateral Decompression with TLIF. Thirty-nine patients (76.47%) presented with back pain and 12 patients (23.53%) presented with leg pain. The average preoperative VAS is 7.60 (5-10). The average VAS at 1 year postoperation are 2.56 (0-5), which was significantly reduced from preoperative assessment ($p < 0.05$).

The NCS was used in this study to evaluate neurogenic claudication symptom. At 1- year follow-up, an average NCS was significantly increased from 24.03 to 70.94 ($p < 0.05$). About Prolo functional and economic scales, the average preoperative scores was 4.05 (2-8) and the average postoperative score was 7.47 (5-10). This change reached statistical significance ($p < 0.05$) (Table 4).

Total 57 levels of transforaminal lumbar interbody fusions (TLIF) were performed in this study. At 1-year follow-up, the fusions were successful in all level without complications. Failure of instrumentation and adjacent segment degeneration were not observed.

Table 4 Comparison outcome of VAS, NCS and Prolo score between pre-operation and one year post-operation

	Pre-operation	One year post- operation	*P*
VAS	7.60 (range 5-10)	2.56 (range 0-5)	< 0.05
NCS	24.03 (range 2-44)	70.94 (range 34-96)	< 0.05
Prolo score	4.05 (range 2-8)	7.47 (range 5-10)	< 0.05

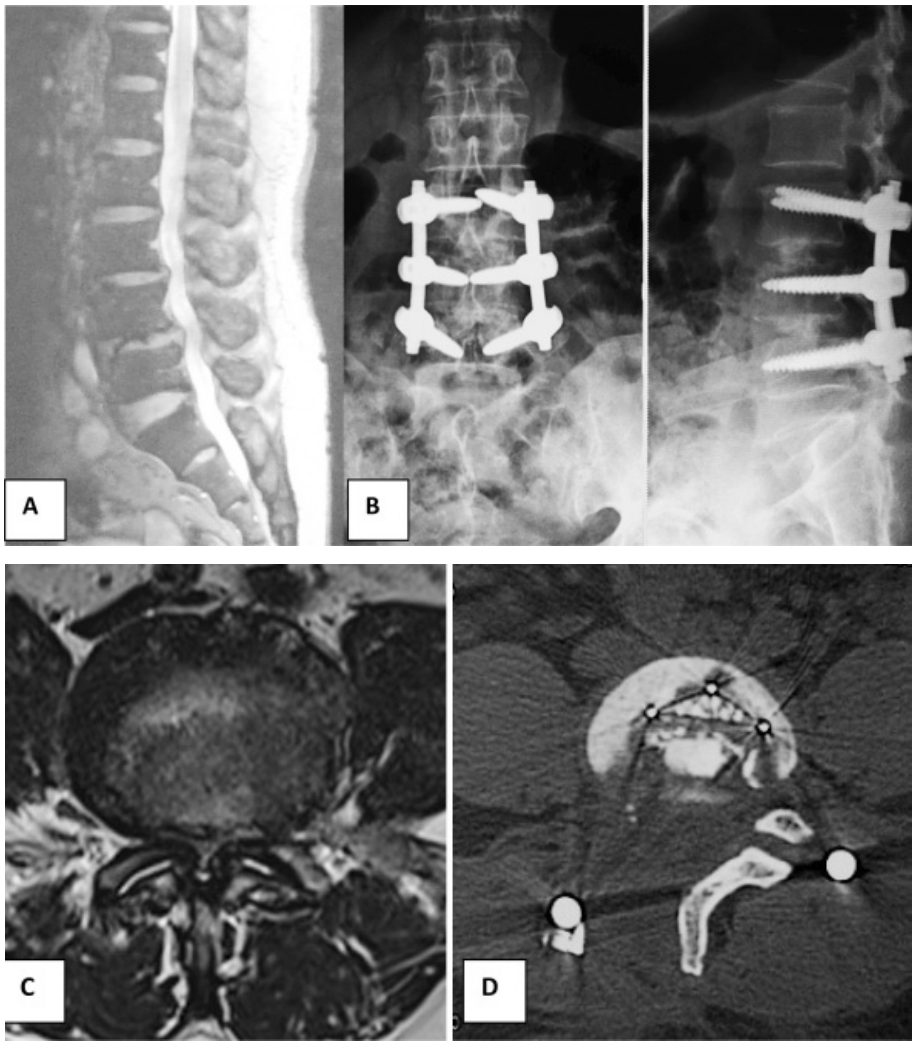

Figure 2 A 56-year-old female patient, Pre-op. MRI : Spondylolisthesis L3-L4, L4-L5 (A), severe spinal canal stenosis on axial view (C), 6 months after unilateral approach for bilateral decompression and fusion at L3-L5 showed no halo around screws and trabecular bone bridge at L4-L5 space on AP plain film (B). Post op Axial CT L4-5 (D)

Discussion

Number of techniques to treat lumbar spinal stenosis have been reported[6,7,8,9]. The procedures share the same purpose which is to decompress the neurological structures. The unilateral approach for bilateral decompression is another technique which theoretically minimizes the surgical insult by limiting the approach only in one side of the spine[6,8,9,13,14]. If degenerative spine problems are complex, most of the patients have a concomitant segmental instability which requires a fusion procedure to provide spinal stability[3,11,15,16]. The authors developed a novel technique called "Unilateral Approach for Bilateral Decompression and Fusion" (UBD & Fusion). Nevertheless, the adequacy and efficacy of this technique have not been investigated. In this paper, the authors studied the efficacy of this technique by comparing preoperative and 1-year postoperative VAS, NCS and Prolo score. Success rate of fusion was also evaluated.

We found significant reduced VAS in patients who were treated with this technique. The VAS reduced from 7.56 (range 5-10) preoperatively, to 2.56 (range 0-5) postoperatively. From NCS, the patients walked longer distance without claudication. The NCS was also significantly higher in postoperative follow-up which indicated adequacy of decompression[9] by this technique. The prolo score was significantly increased which indicated overall functional improvement[2,5].

Intervertebral fusions in this study were all archived in one year after operation. No adjacent segment degeneration, spondylolisthesis and instrument failure were found in our study. The results showed effectiveness of this technique for degenerative spinal stenosis with segmental instability.

With the proposed technique, the unilateral approach in more pronounced compressive symptoms allowed operating surgeon to view all around affected nerve root clearly especially the ventral side which can be compressed by nucleus pulprosus. With an aid of microscope used in this technique, it gave small working window yet adequate for contralateral side decompression[15]. The transpedicular screw fixation and TLIF can be proceeded after decompression in this unilateral approach after unilateral facetectomy and discectomy. The PEEK cage and bone graft can be passed through this small space to the intervertebral space without difficulty[3,12,15].

The TLIF provided long-term stability for unstable spinal segment. Moreover, the interbody fusion give anterior support[18] and restore lumbar lordosis[1,3,15] to spinal column unlike traditional posterolateral fusion. The total facetectomy provided a room for interbody fusion without unevitible excessive nerve root retraction in PLIF[15,17,18]. Thus, TLIF is a preferred method of intervertebral fusion in unilateral approach. An autologous bone graft in intervertebral space and on contralateral lamina enhanced fusion capability in this technique[4,14,16]. Thus, we found fused intervertebral segment in our study. Another benefit of unilateral approach for bilateral decompression and fusion is preserving the posterior elementous complex[7]. Together with posterior instrumentation, they are the key posterior support to prevent adjacent segment degeneration[7] in our study.

The limitation of present study is relatively short-term follow-up of only one year after the index operation. The adjacent segmental instability may not be demonstrated in this duration. The spinal fusion can be properly evaluated by more sophisticate method, such as CT scan, to detect the fusion. Because this technique gives only small working window, the operation requires experienced surgeon who is familiar with distorted degenerative spine.

The result of this proposed technique is promising. It has a potential to be an option for degenerative lumbar spine with nerve root compression and segmental instability. However, the results have to be followed for longer period to evaluate the long-term results. And further study is needed to compare with other decompression and spinal fusion techniques.

Conclusion

The novel technique by unilateral approach for bilateral decompression with fusion is encouraging and safe. This technique gives an adequate bilateral decompression while preserving important posterior stabilizer. The intervertebral fusion by TLIF is also feasible in this small approach with high fusion success rate.

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