www.jkns.or.kr 10.3340/jkns.2011.49.3.163 Print ISSN 2005-3711 On-line ISSN 1598-7876
J Korean Neurosurg Soc 49 : 163-166, 2011

Clinical Article

Paraspinal Muscle Sparing versus Percutaneous Screw Fixation : A Prospective and Comparative Study for the Treatment of L5-S1 Spondylolisthesis

Kun Soo Jang, M.D.,[1] Heyun Sung Kim, M.D., Ph.D.,[2] Chang Il Ju, M.D., Ph.D.,[1] Seok Won Kim, M.D., Ph.D.,[1] Sung Myung Lee, M.D., Ph.D.,[1] Ho Shin, M.D., Ph.D.[1]

Department of Neurosurgery,[1] College of Medicine, Chosun University, Gwangju, Korea
Department of Neurosurgery,[2] Heori Sarang Hospital, Daejeon, Korea

Objective : Both the paraspinal muscle sparing approach and percutaneous screw fixation are less traumatic procedures in comparison with the conventional midline approach. These techniques have been used with the goal of reducing muscle injury. The purpose of this study was to evaluate and to compare the safety and efficacy of the paraspinal muscle sparing technique and percutaneous screw fixation for the treatment of L5-S1 spondylolisthesis.

Methods : Twenty patients who had undergone posterior lumbar interbody fusion (PLIF) at the L5-S1 segment for spondylolisthesis were prospectively studied. They were divided into two groups by screw fixation technique (Group I : paraspinal muscle sparing approach and Group II: percutaneous screw fixation). Clinical outcomes were assessed by Low Back Outcome Score (LBOS) and Visual Analogue Scale (VAS) for back and leg pain at different times after surgery. In addition, modified MacNab's grading criteria were used to assess subjective patients' outcomes 6 months after surgery. Postoperative midline surgical scarring, intraoperative blood loss, mean operation time, and procedure-related complications were analyzed.

Results : Excellent or good results were observed in all patients in both groups 6 months after surgery. Patients in both groups showed marked improvement in terms of LBOSs all over time intervals. Postoperative midline surgical scarring and intraoperative blood loss were lower in Group II compared to Group I although these differences were not statistically significant. Low back pain (LBP) and leg pain in both groups also showed significant improvement when compared to preoperative scores. However, at 7 days and 1 month after surgery, patients in Group II had significantly better LBP scores compared to Group I.

Conclusion : In terms of LBP during the early postoperative period, patients who underwent percutaneous screw fixation showed better results compared to ones who underwent screw fixation via the paraspinal muscle sparing approach. Our results indicate that the percutaneous screw fixation procedure is the preferable minimally invasive technique for reducing LBP associated with L5-S1 spondylolisthesis.

Key Words : Spondylolisthesis · Paraspinal muscle sparing approach · Percutaneous screw fixation · Back pain.

INTRODUCTION

Posterior lumbar interbody fusion (PLIF) is a widely performed surgical procedure for the management of pain and spinal instability resulting from spondylolisthesis[7,10]. Posterior instrumentation is frequently used to augment interbody fusion, and pedicle screws with rods are commonly employed for this purpose. However, traditional open PLIF for instrument implantation requires a large midline skin incision and extensive dissection of the paraspinal muscles that can increase the risk of complications over both the short and long term[6,10]. Furthermore, it is known that medially-oriented pedicle screw placement is necessary to obtain a secure anchor to the sacrum for screw fixation at the L5-S1 level[3]. However, for the conventional midline approach for screw fixation at the L5-S1 level, forceful retraction of the paraspinal muscles is required to achieve the proper lateral-to-medial screw trajectory due to coronal plane angle increase of pedicle. In contrast, both screw fixation via the paraspinal muscle sparing approach and percutaneous screw fixation are known to significantly diminish the risk for complications such as iatrogenic muscle injury and postoperative back pain. Compared to conventional open PLIF, these techniques can reduce intraoperative blood loss, decrease postoperative elevation of pro-inflammatory cytokine levels, and

• Received : November 12, 2010 • Revised : February 21, 2011
• Accepted : March 3, 2011
• Address for reprints : Seok Won Kim, M.D.
Department of Neurosurgery, College of Medicine, Chosun University,
588 Seoseok-dong, Dong-gu, Gwangju 501-717, Korea
Tel : +82-62-220-3126, Fax : +82-62-227-4575
E-mail : ns64902@hanmail.net/chosunns@chosun.ac.kr

postoperative back pain[1,8]. So far, no study has yet addressed the best surgical approach to reduce LBP for L5-S1 spondylolisthesis, and which is the less invasive technique. The purpose of this prospective and comparative study was to investigate the safety and efficacy of less invasive techniques for screw fixation, namely the paraspinal muscle sparing approach and percutaneous screw fixation technique, for treating spondylolisthesis at the L5-S1 level.

MATERIALS AND METHODS

A total of 20 patients who underwent single level PLIF to treat L5-S1 spondylolisthesis were studied. Patients with chronic illness, or a history of malignancy or infectious disease were excluded from this study. Twenty patients were classified into two groups. Group I consisted of 10 patients (three males and seven females) treated by PLIF using interbody cages and the paraspinal muscle sparing approach for screw fixation. A clear plane was identified between the multifidus medially and the longissimus laterally for placement of pedicle screws. Group II consisted of 10 patients (four males and six females) treated by PLIF using interbody cages and percutaneous screw fixation. Patient outcomes before surgery and 7 days, 1 month, 3 months, and 6 months following the operation, were assessed and radiographs were obtained. Outcomes were measured according to the Low Back Outcome Score (LBOS) normalized to 75 (Table 1). LBP and leg pain were measured separately using a self-assessment 10-point VAS. In addition, modified MacNab's grading criteria were used to assess the subjective patient outcomes 6 months after surgery. Perioperative parameters and complications of each group were analyzed. Radiographs included upright anteroposterior, lateral, and flexion-extension images. Angulation of less than 4° on flexion-extension radiographs and absence of radiolucency were considered to be evidence of fusion course. All patients were instructed to wear a thoraco-lumbo-sacral orthosis (TLSO) when out of bed until 3 months post-surgery.

Statistical analysis

Differences in demographic and preoperative data of mean value (MV) and standard deviations (SD) were assessed by analysis of variance for continuous variables and Fisher's exact test for categorical variables. Differences in continuous outcome measurements between the two groups were evaluated using the analysis of covariance with the preoperative score as the covariate. For assessing the statistical significance of postoperative

Table 1. The low back outcome scale of Greenough and Fraser

Parameter	Finding	Points	Parameter	Finding	Points
Current pain	7 to 10 cm VAS	0	Sex life	Severely affected impossible	0
	5 to 6 cm VAS	3		Moderately affected difficult	2
	3 to 4 cm VAS	6		Mildly affected	4
	0 to 2 cm VAS	9		Unaffected	6
Employment	Unemployed because of back pain	0	Sleeping	Severely affected impossible	0
	Part time	3		Moderately affected difficult	1
	Full time lighter	6		Mildly affected	2
	Full time original	9		Unaffected	3
Domestic chores odd jobs	None	0	Walking	Severely affected impossible	0
	A few but not many	3		Moderately affected difficult	1
	Most or all but more slowly	6		Mildly affected	2
	Normally	9		Unaffected	3
Sport or active social activities	None	0	Sitting	Severely affected impossible	0
	Some but much less than before	3		Moderately affected difficult	1
	Back to previous level	9		Mildly affected	2
Resting	Resting more than half the day	0		Unaffected	3
	Little rest needed occasional	4	Travelling	Severely affected impossible	0
	No need rest	6		Moderately affected difficult	1
Treatment or consultation	More than once per month	0		Mildly affected	2
	About once per month	2		Unaffected	3
	Rarely	4	Dressing	Severely affected impossible	0
	Never	6		Moderately affected difficult	1
Analgesia	Several times each day	0		Mildly affected	2
	Almost every day	2		Unaffected	3
	Occasionally	4	Total		75
	Never	6			

improvement in outcome scores from the preoperative status within each treatment group, a paired Student's t-test was used. For comparing event rates, Fisher's exact test was used. Two-sided p values were reported for comparing differences between the two groups. p-value of less than 0.05 was considered to be statistically significant.

RESULTS

There were no significant differences between Group I and Group II with respect to age, gender, or type of spondylolisthesis. The mean operative time from skin incision to complete wound closure was 208.4 minutes (range, 178-230 minutes) in Group I and 151.7 minutes (range, 125-187 minutes) in Group II (p=0.083). The amount of intraoperative blood loss, postoperative blood transfusion and midline skin incision were also higher in Group I than Group II, even though these differences were not statistically significant (Table 2). All patients in both groups were found to have excellent or good results according to modified MacNab's criteria. The average LBOS for Group I and Group II improved significantly from preoperative scores of 31.6 and 30.5 to 60.2 and 58.4 at 6 months, respectively (p<0.001). Both groups showed similar improvements over all time intervals (Fig. 1) with no statistically significant differences in their 6 month average LBOS (p= 0.622). Back pain score (VAS) in both groups showed statistically significant improvement based on comparison to preoperative scores (p<0.001). However, 7 days and 1 month after surgery, patients in Group II had significantly low back pain scores compared to Group I (Fig. 2). After 3 months, no statistically significant differences were noted between the groups. Leg pain score (VAS) after surgery in both Group I and Group II showed an improvement in a similar manner over all time intervals (Fig. 3). The average leg pain scores for the two groups improved from 6.17 and 6.08 to 1.55 and 1.32 at 6 months, respectively, (p<0.001). In both groups, there were no evidence of fusion failure such as angulation of more than 4° on flexion and extension radiographs and radiolucency at the 6-month follow-up. Moreover, no patient experienced neurological sequelae as a result of misplaced pedicle screws.

Table 2. Patients demographics and backgrounds

	Group I (Paraspinal approach)	Group II (Percutaneous screw fixation)	p
Age(yr)	65.1±15.8	63.5±18.2	0.624
Male : Female (%male)	3 : 7 (30%)	4 : 6 (40%)	0.873
Spondylolisthesis			
Degenerative	7	7	
Spondylolytic	3	3	
Time for operation (min)	208.4 (178-230)	151.7 (125-187)	0.083
Intraoperative blood loss (mL)	448.5 (381-608)	302.3 (278-396)	0.162
Transfusion (pint)	1.3 (0-2)	0.4 (0-2)	0.172
Midline skin incison (cm)	10.0 (8.5-12.4)	7.8 (6.8-9.0)	0.355

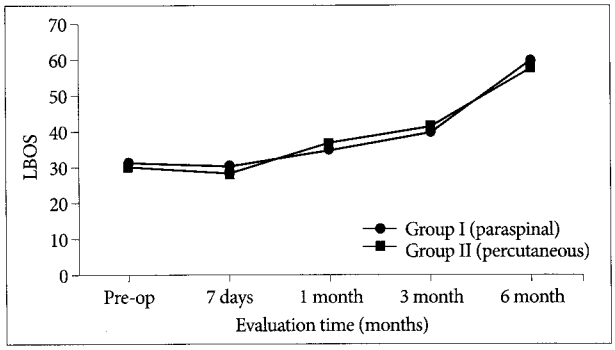

Fig. 1. Mean Low Back Outcome Score in the Group I and Group II at the different time intervals. No difference between groups is present at any time period.

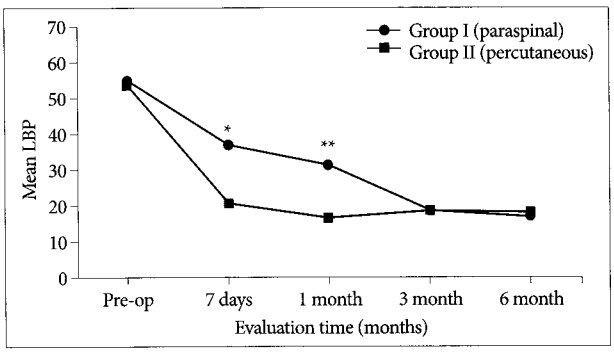

Fig. 2. Mean low back pain scores in the Group I and Group II at the different time intervals. The Group II (Percutaneous screw fixation) shows lower back pain scores compared to Group I significantly on postoperative 7 days (*p=0.005) and 1 month (**p=0.037).

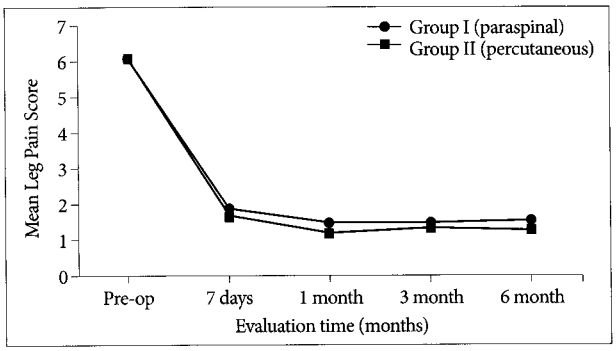

Fig. 3. Mean leg pain scores in the Group I and Group II at the different time intervals. No difference between groups is present at any time period.

DISCUSSION

Traditional procedures for symptomatic spondylolisthesis involve spinal decompression and fusion with supplemental instrumentation[7]. PLIF has been associated with improvement of the fusion rate while restoring disc height and maintaining vertebral alignment. However, despite the advantage of a satisfactory rate of fusion, PLIF itself has some drawbacks. Due to the massive skin incision, the risk for intraoperative blood loss and

postoperative back pain are increased. In addition, for the conventional midline approach for screw fixation at L5-S1 levels, forceful retraction of the paraspinal muscles is required to achieve the proper lateral-to-medial screw trajectory because of coronal plane angle of pedicle. Subsequent prolonged wide retraction may result in denervation of the paraspinal musculature[8]. Self-retaining retractors cause a significant rise in intramuscular pressure in the erector spinae muscles which is maintained throughout the surgical procedure[9]. Moreover, the procedure can potentially injure the medial branches of the dorsal ramus at adjacent levels and at the level of fusion; this is because these branches are relatively fixed as they run beneath the fibro-osseous mamilloaccessory ligament[2]. In contrast, several authors have recently reported that the muscle paraspinal sparing approach causes less paraspinal muscle damage than the traditional midline approach, and has positive effects on postoperative trunk muscle performance[3,5]. The paraspinal approach can also result in a more medially-oriented S1 pedicle screw placement than traditional midline approach, which should lead to stronger fixation. However, the results of the current study demonstrate that percutaneous screw fixation causes less LBP than screw fixation via the paraspinal muscle sparing approach. It is known that postoperative back pain is caused by muscle injury during surgery and is directly related to the operation time and external compression force from the retractor[6]. This study demonstrated that the mean operative time and estimated blood loss seemed low in the Group II (percutaneous screw fixation group). All outcome measurements in both groups showed significant improvement at 6 months after operation. However, we observed a significant difference in the reduction of LBP between the two groups at 7 days and 1 month following the operation. At these two times, patients in Group II had significantly better LBP scores compared to patients in Group I. This may indicate that the paraspinal muscle sparing approach for placement of pedicular screws is associated with longer incisions, extensive deflection of muscle, longer operative time, and greater blood loss compared to percutaneous screw fixation. As a result, we believe that systemic inflammatory reactions are high in patients who underwent the paraspinal muscle sparing approach compared to patients who underwent percutaneous screw fixation. Although this was prospective study, it had a small patient group. Further investigations including a more rigorous selection of patients are needed in the future.

CONCLUSION

Although screw fixation via the paraspinal muscle sparing approach and percutanoeus screw fixation are satisfactory techniques that result in reduced muscle injury, percutaneous screw fixation can reduce LBP more effectively in the early postoperative period for treatment of L5-S1 spondylolisthesis.

References

1. Anand N, Baron EM, Thaiyananthan G, Khalsa K, Goldstein TB : Minimally invasive multilevel percutaneous correction and fusion for adult lumbar degenerative scoliosis : a technique and feasibility study. **J Spinal Disord Tech 21** : 459-467, 2008
2. Bogduk N, Wilson AS, Tynan W : The human lumbar dorsal rami. **J Anat 134** : 383-397, 1982
3. de Peretti F, Argenson C, Bourgeon A, Omar F, Eude P, Aboulker C : Anatomic and experimental basis for the insertion of a screw at the first sacral vertebra. **Surg Radiol Anat 13** : 133-137, 1991
4. Fritzell P, Hägg O, Wessberg P, Nordwall A : Chronic low back pain and fusion : a comparison of three surgical techniques: a prospective multicenter randomized study from the Swedish lumbar spine study group. **Spine 27** : 1131-1141, 2002
5. Hyun SJ, Kim YB, Kim YS, Park SW, Nam TK, Hong HJ, et al. : Postoperative changes in paraspinal muscle volume : comparison between paramedian interfascial and midline approaches for lumbar fusion. **J Korean Med Sci 22** : 646-651, 2007
6. Kawaguchi Y, Matsui H, Tsuji H : Back muscle injury after posterior lumbar spine surgery. A histologic and enzymatic analysis. **Spine 21** : 941-944, 1996
7. Kim HS, Park IH, Ryu JK, Kim SW, Shin H : Bone cement augmentation of pedicular screwing in severe osteoporotic spondylolisthetic patients. **J Korean Neurosurg Soc 42** : 6-10, 2007
8. Ota M, Neo M, Fujibayashi S, Takemoto M, Nakamura T : Advantages of the paraspinal muscle splitting approach in comparison with conventional midline approach for s1 pedicle screw placement. **Spine 35** : E452-E457, 2010
9. Styf JR, Willén J : The effects of external compression by three different retractors on pressure in the erector spine muscles during and after posterior lumbar spine surgery in humans. **Spine 23** : 354-358, 1998
10. Wetzel FT, LaRocca H : The failed posterior lumbar interbody fusion. **Spine 16** : 839-845, 1991