International Research on Medical Sciences Vol.2(6), pp. 092-096, December, 2014
Available online at http://www.apexjournal.org
ISSN 2315-8845© 2014 Apex Journal International

Full Length Research

Reduction versus *in situ* fusion in surgical treatment of lumbar degenerative spondylolisthesis

Farzad Omidi-Kashani,*[1] Ebrahim Ghayem Hasankhani[2] and Hossein Heidari[3]

Orthopedic Department, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.

Accepted 6 November, 2014

Lumbar Degenerative Spondylolisthesis (LDS) is a degenerative slippage of the lumbar vertebra. The aim of this study is to evaluate the role of vertebral reduction in surgical outcome of the patients with LDS. This retrospective study was conducted on 132 surgically treated patients from August 2003 to January 2011. We placed our patients into two Group A (46 cases, in situ fusion) and Group B (86 cases with slippery reduction) with the mean follow-up 80.3±15.45 and 33.4±5.59 (24-48) months, respectively. Patients' disability and pain were assessed by Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS). Radiographic data and subjective recovery rate were also evaluated. The two groups were homogeneous for age and sex. In Group B, the mean slip correction rate was 52.2 ± 11.6% (ranged; 21-95%) with a mean loss of correction of 4.8 ± 1.1% (ranged; 0-11%) at the last follow-up visit. In Group A, VAS and ODI improved from 8.5±1.20 and 71.7±10.31, preoperatively to 2.3±2.46 and 22.7±12.10 postoperatively, respectively. Similarly, in Group B, VAS and ODI changed from preoperative 8.7±1.47 and 71.8±16.11 to postoperative 2.2±2.51 and 28.6±20.56, respectively. In surgical treatment of the patients with LDS, no relationship was found between slippery reduction and functional recovery. Therefore, it's better to avoid this unnecessary and time consuming step in these relatively old patients.

Key words: Lumbar Spine, Degenerative Spondylolisthesis, Spinal Fusion, Reduction.

INTRODUCTION

Lumbar degenerative spondylolisthesis (LDS) is a degenerative slippage of one vertebra over the adjacent inferior one in the absence of a defect in posterior vertebral elements (Mardjetko et al., 1994). When the intervertebral disc space decreases or osteophytes appear, slip progression is less likely to happen (Benoist, 2002). Progression of vertebral slippage is not associated with worsening of clinical symptoms (Hilibrand and Rand, 1999). A thorough history and physical examination can be very helpful in deciding treatment (Benoist, 2002; Hilibrand and Rand, 1999).

The vast majority of the patients with LDS are sub-clinical, but in symptomatic cases, non-surgical care can still efficiently improve most complains (Bassewitz and Herkowitz, 2001). In refractory patients with neurologic deficit (substantial sensory, motor, and/or sphincter disturbances) or in the presence of rest pain, surgical intervention is recommended (Bassewitz and Herkowitz, 2001; Herkowitz, 2009; Watters et al., 2009).

General principles of surgery in these patients include neural decompression, intervertebral fusion, and instrumentation that usually performed by pedicular screw and rod constructs (Gibson and Waddell, 2005). Although there are arguments about routine use of fusion and/or instrumentation in surgical treatment of these patients, slippery reduction is probably the most controversial issue (Watters et al., 2009; Gibson and Waddell, 2005; Metz-Stavenhagen et al., 1997). The aim of this study is to evaluate the role of vertebral reduction in surgical outcome of the patients with LDS.

MATERIALS AND METHODS

Following institutional review board approval, this

*Corresponding author. Email: omidif@mums.ac.ir, drfarzadkashani@me.com

retrospective study was conducted on the surgically treated patients from August 2003 to January 2011. We placed our patients into two groups. From August 2003 to July 2008 (Group A), we surgically treated the patients with decompression, *in situ* fusion, and pedicular screw and rod instrumentation. From August 2008 to November 2012 (Group B), we decided to change the surgical plan and added slippery reduction to the previous routine neural decompression and instrumented in situ posterolateral fusion.

Our entry criteria for this study comprised primary LDS (with no history of preceding lumbar surgery), refractory to a trial of three months aggressive conservative treatment, presence of substantial rest pain, or significant neurologic deficit. We excluded those cases with associated significant co-morbidity (like uncontrolled diabetes mellitus or autoimmune diseases, severe hip or knee osteoarthritis, underlying malignancy), and those with less than two years of follow-up.

Preoperatively, we took standing radiographs and magnetic resonance imaging scan of the lumbosacral spine for all the cases. Slip percentage was measured as a percentage of slippery displacement of the upper vertebral on the top of the lower one on the standing radiographs (Taillard, 1954). Correction rate (in Group B) was calculated as slip percentage difference (pre- and postoperative) divided by preoperative slip percentage multiplied by 100. We evaluated patients' disability and pain by Oswestry Disability Index (ODI) questionnaire version 2.1 and Visual Analogue Scale (VAS) on a zero to ten numerical rating scales (Fairbank and Pynsent, 2000; Wewers and Lowe, 1990; Mousavi, 2006). Pursuant to criteria derived from the North American Spine Society Low Back Outcome Instrument, at the last follow-up visit we asked the patients to select one of the options below regarding their happiness with the surgical management (Wood and Hanley, 1991)

1. "Surgery fulfilled my expectations";
2. "I did not get better as much as I had expected but I would endure the same surgical procedure for the same result";
3. "Surgery helped but I would not endure the same management for the same result"; or
4. "I have not changed or I'm even worse than I was before surgery".

Throughout this period of time, the surgical technique in each group was identical and all the cases signed the informed consents.

Surgical Technique: Complete neural decompression, posterolateral vertebral fusion, and pedicular screw and rod instrumentation were performed for all the patients as previously described (Bassewitz and Herkowitz, 2001). To reduce the slipped vertebra, depending upon the amount of slippage we inserted the proximal screws more deeply relative to the distal screws. Then, longitudinal rods were inserted and distal screws tightened. With simultaneous proximal screws tightening and applying mild longitudinal distraction between proximal and distal screws, we tried to reduce the slipped vertebra to the original place.

On the next day or two days later, the patients were ambulated with a rigid lumbosacral orthosis. This brace was worn for three months. In follow-up visits (at 1.5 months and then every 6 months), we assessed the patients with physical examination and plain radiographs and the questionnaires were fulfilled annually. As many of psudoarthroses are asymptomatic, we used computerized tomography in only symptomatic cases to rule out non-union. All the significant intra- and postoperative complications were recorded.

Statistics: The continuous variables were expressed as mean ± standard deviation (SD). Mean values were compared using Student's t-test or Mann-Whitney U test according to distribution. Categorical variables were compared using the Fisher's exact test. Statistical significance was determined using 5% significance level ($P < 0.05$). Statistical analysis was performed using SPSS 11.5 for Windows (SPSS Inc., Chicago, IL, USA).

RESULTS

After reviewing patients' clinical records and considering the inclusion and exclusion criteria, 50 patients for Group A and 92 for Group B were taken into account. Ultimately due to defects in the follow-up, the number of patients was reduced to 46 and 86, respectively. Demographic data of the patients are shown in Table 1. As can be inferred from the table, the two groups were homogeneous for age and sex. Prevalence of spondylolisthesis at different levels is also shown in Table 2.

In Group B, the mean slip correction rate was 52.2 ± 11.6% (ranged; 21-95%) with a mean loss of correction of 4.8 ± 1.1% (ranged; 0-11%) at the last follow-up visit. Surgical outcome and satisfaction rate are displayed in Table 3. Levels of pain (VAS) and disability (ODI) in our patients preoperatively and postoperatively at the last follow-up visits were similar, statistically. In other words, slippery reduction had not a useful role in improving functional results of surgery in our patients.

We did not encounter any significant neurologic complications in our treated patients requiring re-operation. Superficial wound infection and wound dehiscence were occurred in four patients in Group A and three in Group B, all in diabetic cases. All these patients had a favorable response to antibiotic treatment, topical wound care and glycemic control. Symptomatic pseudoarthrosis associated with screw breakage occurred

Table 1. Demographic data of our treated patients.

	Number	Sex (Male/Female)	Mean age (Range; year)	Mean follow-up (Range; month)
Group A	46	2/44	58.5±8.91 (45-74)	80.3±15.45 (53-112)
Group B	86	14/72	59.3±9.61 (41-76)	33.4±5.59 (24-48)
P value	-	0.244✧	0.763×	<0.0001×

✧Fisher's exact test
×Student's t-test

Table 2. Prevalence of spondylolisthetic levels in our treated patients.

	Frequency	Percent
Group A		
L4-L5	34	73.9
L5-S1	10	21.7
L4-L5 & L5-S1	2	4.3
Total	46	100
Group B		
L4-L5	72	83.7
L5-S1	2	2.3
L4-L5 & L5-S1	2	2.3
L2-L3	3	3.5
L3-L4	3	3.5
L3-L4 & L4-L5	4	4.7
Total	86	100

Table 3. Surgical outcome and satisfaction rate in the patients.

	Preoperative		Last Visit		Mean Patients'
	Mean VAS	Mean ODI	Mean VAS	Mean ODI	Satisfaction Score (SD)
Group A	8.5±1.20	71.7±10.31	2.3±2.46	22.7±12.10	1.5±0.66
Group B	8.7±1.47	71.8±16.11	2.2±2.51	28.6±20.56	1.6±0.93
P value	0.412✧	0.994×	0.650✧	0.207×	0.919✧

✧ Mann-Whitney U test
× Student's t-test

in two patients in Group B weighing 138 and 121 kilograms. Both of them were at L4-L5 level and treated with anterior lumbar interbody fusion and instrumentation.

DISCUSSION

In this study, we retrospectively evaluated two relatively homogenous groups of LDS patients that were surgically treated with *in situ* versus reduction instrumented spondylodesis. The results indicated that although slippery reduction has not been associated with more surgical complication, the patients have not been given much benefit as well. Perhaps one reason for the lack of effectiveness of slippery reduction in the clinical outcome of these patients is the relatively low grade nature of this type of spondylolisthesis (with slip percentage less than 30% in most of the cases). Therefore, this logical deduction may not be applicable in other types of spondylolisthesis.

Although the essential component of the surgery in these patients is neural decompression, there are a lot of controversies about the need for spinal fusion, instrumentation, and slippery reduction (Sengupta and Herkowitz,

2005; Molina et al., 2011). Decompression relieves radicular complains and neurogenic claudication, while fusion by removing vertebral instability can lead to back pain relief. Instrumentation promotes the fusion rate, although it is not necessarily associated with better clinical recovery (Fischgrund et al., 1997). And finally, slippery reduction restores normal spinal alignment and anatomy.

Perhaps the most controversial part of the surgical treatment in LDS is the efficacy of reduction on clinical outcome of surgery in these patients. Montgomery and Fischgrund in a prospective study on 24 cases with lumbar isthmic or degenerative spondylolisthesis observed that prone lateral lumbosacral radiography obtained in anesthetic patients could passively reduce slip percentage from 24% to 6%, independent of disc height, slip angle, type and level of spondylolisthesis (Montgomery and Fischgrund, 1994). They recommended this indirect reduction technique instead of direct instrumented manipulation to decrease the risk of associated complications and the need for extra level spondylodesis. In the study we conducted, all the surgical procedures were carried out in prone positioning on two longitudinal roles to be able to use the benefits of this passive reduction effect.

Bednar carried out a research on 56 cases with LDS. In his study, he preserved lamina but performed limited foraminotomy to decompress the root and reduced the spondylolisthesis using a reduction instrument without any associated interbody fusion (Bednar, 2002). The mean follow-up period was 33 months clinically (with ODI assessment) and 28 months, radiologically. He finally achieved the clinical results comparable to routine laminectomy and in situ fusion, but loss of correction occurred in 16% cases and loss of disc height restoration in all patients. He recommended that in the patients with LDS, laminectomy may not be necessary when slippery reduction is achieved, although it's better to use some kind of interbody device to prevent loss of correction. In our study, we did not rely on foraminotomy alone and performed laminoectomy associated with slippery reduction without using any interbody device. The mean loss of slippery reduction in our study was 4.8±1.1% (ranged; 0-11%).

Conversely, in a retrospective study conducted by Kawakami et al. on 47 patients with LDS, they found vertebral reduction as an effective factor in determining the clinical recovery (Kawakami et al., 2002). In their research, L1 axis S1 distance (the horizontal space between plumb line of the L1 centrum and posterior corner of S1 vertebral body) was used as an indicator for lumbar spinal alignment. They reported higher recovery rate and lower low back pain in the patients with reduced slippage as compared with the cases with in situ spondylodesis. They concluded that this improved clinical outcomes are more prominent in those cases with preoperative L1 axis S1 distance more than 35 mm. We placed slip percentage as an index for vertebral reduction and found no relationship between this index and functional recovery.

To reduce the slippage, we inserted proximal screws more deeply as compared with distal ones. In assembling the longitudinal rods, we first tightened distal screws as a base of construct, and then with applying mild distracting force between distal and proximal screws, the later ones were tightened. Weisskopf in 2006 published the clinical efficacy of another reduction technique by temporary adjacent segment distraction on 32 patients with spondylolisthesis (Weisskopf et al., 2006). He used cranial adjacent vertebra for temporary instrumentation and distraction to facilitate slippery reduction. Then, he performed some kind of lumbar interbody fusion (transforaminal or anterior depending upon the amount of degenerative shortening of the anterior longitudinal ligament. No comparison between reduction and in situ fusion was carried out and type of the spondylolisthesis was not determined. They reported reduction rate 81% (on average), fusion rate 100%, and dissimilar improvement in all categories of the short form 36. In our research, the correction rate (in group B) was 52.2 ± 11.6% (ranged; 21-95%).

Our study has some drawbacks. One of the defaults is its retrospective design. These kinds of studies evaluate the factors related to the development of a particular outcome after the outcome has already happened. Therefore, they are subject to recall bias. Another disadvantage of this study was to investigate only the cases with small amount of displacement (slip percentage less than 30% is the law in LDS). Perhaps a prospective case-control study conducted on a variety kind of spondylolisthesis with different amount of displacement could lead to another result. In conclusion, we could not find any relationship between slippery reduction and functional recovery of the patients with LDS. In order to save the surgical operating time in the patients with LDS, it is probably better not to try to reduce the slipped vertebra.

ACKNOWLEDGMENT

We thank the respectable head of Imam Reza Hospital, Dr M. A. for his cooperation and assistance in this research.

REFERENCES

Bassewitz, H., Herkowitz, H. (2001). Lumbar stenosis with spondylolisthesis: current concepts of surgical treatment. *Clin. Orthop. Relat. Res.* 384: 54-60.

Bednar, D.A. (2002). Surgical management of lumbar

degenerative spinal stenosis with spondylolisthesis via posterior reduction with minimal laminectomy. *J. Spinal Disord. Tech.* 15(2): 105-109.

Benoist, M. (2002). The natural history of lumbar degenerative spinal stenosis. *Joint Bone Spine* 69(5): 450-7. Review.

Fairbank, J.C., Pynsent, P.B. (2000). The Oswestry Disability Index. *Spine*, 25(22): 2940-52.

Fischgrund, J.S., Mackay, M., Herkowitz, H.N., Brower, R., Montgomery, D.M., Kurz, L.T. (1997) Volvo Award winner in clinical studies. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective, randomized study comparing decompressive laminectomy and arthrodesis with and without spinal instrumentation. *Spine* 22(24): 2807-12.

Gibson, J.N., Waddell, G. (2005). Surgery for degenerative lumbar spondylosis. Cochrane Database *Syst. Rev.* 4: CD001352.

Herkowitz, H.N. (2009). Degenerative lumbar spondylolisthesis: evolution of surgical management. *Spine J.* 9(7): 605-6.

Hilibrand, A.S., Rand N. (1999). Degenerative lumbar stenosis: diagnosis and management. *J. Am. Acad. Orthop. Surg.* 7(4): 239-49.

Kawakami, M., Tamaki, T., Ando, M., Yamada, H., Hashizume, H., Yoshida, M. (2002). Lumbar sagittal balance influences the clinical outcome after decompression and posterolateral spinal fusion for degenerative lumbar spondylolisthesis. *Spine* 27(1): 59-64.

Mardjetko, S.M., Connolly, P.J., Shott, S. (1994). Degenerative lumbar spondylolisthesis. A meta-analysis of literature 1970–1993. *Spine* 19: 2256S–65S.

Metz-Stavenhagen, P., Sambale, R., Völpel, H.J., von Stavenhagen, N. (1997). Treatment of spondylolisthesis. Operation in situ or repositioning spondylodesis. *Orthopade* 126(9): 796-803.

Molina, M., Wagner, P., Campos, M. (2011). Spinal lumbar stenosis: an update. *Rev. Med. Chil.* 139(11): 1488-95.

Montgomery, D.M., Fischgrund, J.S. (1994). Passive reduction of spondylolisthesis on the operating room table: a prospective study. *J. Spinal Disord.* 7(2): 167-72.

Mousavi, S.J., Parnianpour, M., Mehdian, H., Montazeri, A., Mobini, B. (2006). The Oswestry Disability Index, the Roland-Morris Disability Questionnaire, and the Quebec Back Pain Disability Scale: translation and validation studies of the Iranian versions. *Spine*, 31(14): E454-9.

Sengupta, D.K., Herkowitz, H.N. (2005). Degenerative spondylolisthesis: review of current trends and controversies. *Spine* 30 (6 Suppl): S71-81.

Taillard, W. (1954). Spondylolisthesis in children and adolescents. *Acta Orthop. Scand.* 24(2): 115-44.

Watters, W.C. 3rd, Bono, C.M., Gilbert, T.J. (2009). An evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spondylolisthesis. *Spine J.* 9(7): 609-14.

Weisskopf, M., Ohnsorge, J.A., Wirtz, D.C., Niethard, F.U. (2006). Reduction of spondylolisthesis by temporary adjacent segment distraction. *Z Orthop Ihre Grenzgeb.* 144(5): 511-555.

Wewers, M.E, Lowe, N.K. (1990). A critical review of visual analogue scales in the measurement of clinical phenomena. *Res. Nurs. Health*, 13(4): 227-236.

Wood, E.G. III, Hanley, E.N. Jr. (1991). Lumbar disc herniation and open limited discectomy: indications, techniques, and results. *Oper. Tech. Orthop.* 1: 23–8.