Slip Reduction Rate between Minimal Invasive and Conventional Unilateral Transforaminal Interbody Fusion in Patients with Low-Grade Isthmic Spondylolisthesis

Chang Hyun Oh1, Gyu Yeul Ji2, Jae Kyun Jeon1, Junho Lee1, Seung Hwan Yoon3, Dong Keun Hyun3

1Department of Neurosurgery, Guro Teun Teun Hospital, Seoul, 2Department of Neurosurgery, Yonsei University College of Medicine, Seoul, 3Department of Neurosurgery, Inha University College of Medicine, Incheon, Korea

Objective: To compare the slip reduction rate and clinical outcomes between unilateral conventional transforaminal lumbar interbody fusion (conventional TLIF) and unilateral minimal invasive TLIF (minimal TLIF) with pedicle screw fixation for treatment of one level low-grade symptomatic isthmic spondylolisthesis.

Methods: Between February 2008 and April 2012, 25 patients with low-grade isthmic spondylolisthesis underwent conventional TLIF (12 patients) and minimal TLIF (13 patients) in single university hospital by a single surgeon. Lateral radiographs of lumbar spine were taken 12 months after surgery to analyze the degree of slip reduction and the clinical outcome. All measurements were performed by a single observer.

Results: The demographic data between conventional TLIF and minimal TLIF were not different. Slip percentage was reduced from 15.00% to 8.33% in conventional TLIF, and from 14.15% to 9.62% in minimal TLIF. In both groups, slip percentage was significantly improved postoperatively (p=0.002), but no significant intergroup differences of slip percentage in preoperative and postoperative were found. The reduction rate also not different between conventional TLIF (45.41±28.80%) and minimal TLIF (32.91±32.12%, p=0.318).

Conclusion: Conventional TLIF and minimal TLIF with pedicle screw fixation showed good slip reduction in patients with one level low-grade symptomatic isthmic spondylolisthesis. The slip percentage and reduction rate were similar in the conventional TLIF and minimal TLIF.

Key Words: Slip percentage ㆍ Reduction rate ㆍ Conventional ㆍ Minimal invasive ㆍ Transforaminal lumbar interbody fusion

INTRODUCTION

Spondylolisthesis is an unstable lumbar disease demonstrated in approximately 6% of the general population and occurs most often at L4-L5 and L5-S1 levels10,13,14. Anatomy research indicates that isthmic spondylolisthesis usually occurs within the scope of 2 to 9 mm beneath the pedicles, resulting in the defects in bony contacts in the pars interarticularis to form pseudarthrosis, the gap of which is filled with fibrous connective tissue and chondroid tissue, which we called pars interarticularis scar3. Symptomatic patients with isthmic spondylolisthesis usually require surgical intervention, the goals of which include the stabilization of the motion segment, the decompression of neural elements, the reconstitution of disc space height, and the restoration of sagittal plane translational and rotational alignment6. Minimally invasive transforaminal lumbar interbody fusion (TLIF) is a relatively novel spinal fusion technique which was developed in recent years on the basis of conventional TLIF3. But, little is known about the slip reduction according to the unilateral TLIF methods. This study was to compare the slip reduction rate and clinical outcome between unilateral conventional TLIF (conventional TLIF) with pedicle screw fixation and unilateral minimal invasive TLIF (minimal TLIF) with pedicle screw fixation for treat-
ment of one level low-grade symptomatic isthmic spondylolisthesis.

**MATERIALS AND METHODS**

1. **Clinical material**

Transforaminal lumbar interbody fusion is a relatively new technique of lumbar arthrodesis via posterior transforaminal approach to the disc, indicated mainly in cases of degenerative disc disease, low grade spondylolisthesis and reoperation for disc herniation, especially when there is indication for interbody fusion and posterior decompression. The main advantage of TLIF is that it allows the complete removal of the intervertebral disc through the vertebral foramen, decompression of the spinal canal and vertebral foramen with minimum risk of neural lesion, due to the access being lateral to the nerve roots.

Between February 2008 and April 2012, 25 patients with low-grade isthmic spondylolisthesis underwent conventional TLIF (12 patients) and minimal TLIF (13 patients) in single university hospital by a single surgeon were included in the study—induding 6 males and 19 females, whose average age was 51.96 years (21-72 years). All of them had preoperative radiographs, computed tomography scans, as well as magnetic resonance imaging, and all surgical procedures were performed by a single surgeon (SHY).

2. **Assessment of slip reduction and clinical results**

Lateral radiographs of lumbar spine were taken 12 months after surgery to analyze the degree of reduction. All measurements were performed by a single observer and were expressed as means±standard deviations. To control for small variations, the radiographic results were represented in percentage. Slip percentage was measured as a percentage of distance from the posterior border of the caudal to the posterior border of the rostral vertebra, normalized to the superior endplate diameter of the former as it presented in Fig. 115. Clinical outcome was measured by visual analog scale (VAS; score range: 0 to 10, with 0 reflecting no pain).

3. **Surgical technique of minimal TLIF**

Fluoroscopy was used to determine the operative level in minimal TLIF technique. The minimal TLIF procedure was performed on the side of radicular symptoms. If both the legs were symptomatic, the approach was from the side of more severe pathology and contralateral lamina and foramina decompressed by a unilateral exposure. An incision was made 3 to 4 cm off midline. Sequential soft tissue dilators were inserted through the incision down to the facet complex until the desired working diameter was achieved. A facetectomy was then performed using a high-speed drill from lateral to medial side to expose the posterolateral aspect of the disc. Intradiscal distraction and disc space preparation were done using standard interbody fusion instruments. Cartilaginous material was removed from the endplates using the endplate scraper. An interbody graft was then placed in a direction anterior and contralateral to the annulotomy within the interbody space. Autograft was not used in any cases. Fluoroscopy was used to ensure satisfactory placement of the graft. When necessary, the contralateral ligamentum flavum was resected to expose the contralateral exiting and traversing nerve roots. If needed, the tubular retractor was angled contralaterally so that a more extensive boney decompression could be done. The tubular retractor was then removed and percutaneous pedicle screws placed immediately above and below the interbody segment to be fused. Under fluoroscopic guidance, a Jamshidi needle was inserted into the pedicles. A K-wire was then passed through the Jamshidi trocar into the pedicles. Using cannulated instruments, a bone tap followed by cannulated screw was advanced over the K-wire. The rod was then placed percutaneously to connect the screws. Compression was applied to the construct before final tightening, providing compression of the bone graft and maximizing lordosis. All
wounds were copiously irrigated and the wounds were closed in layers.

4. Surgical technique of conventional TLIF

A midline skin incision was used in conventional TLIF. The fascia was incised and the paravertebral muscles were dissected from the spine. Radiographs were used to check the appropriate level. Bilateral pedicle screw rod constructs were inserted and laminectomy and unilateral facetectomy was then performed at that level. This was followed by unilateral anulotomy, discectomy, and placement of the interbody graft. Similar to the minimal TLIF approach, cartilaginous material was removed from the endplates using the endplate scraper. Interbody graft was then placed anteriorly and contralateral to the anulotomy within the interbody space. For posteriorlateral arthodesis, local autogenous bone with or without bone extenders was used for bone grafting. The wound was copiously irrigated and closed in layers.

5. Statistical analysis

SPSS software for Windows (SPSS Inc., Chicago, IL, USA) was used throughout, and statistical significance was accepted for p values of <0.050. Data were analyzed using the student, student paired t-test, and chi-square test.

RESULTS

The demographic data between conventional and minimal TLIF were not different (Table 1). All the cases were followed up more than 12 months. Slip percentage was reduced from 15.00±6.66% to 8.33±5.31% in conventional TLIF, and from 14.15±3.76% to 9.62±5.42% in minimal TLIF (Table 2). In both groups, slip percentage was significantly improved postoperatively (p=0.002), but no significant intergroup differences of slip percentage in preoperative and postoperative were found (Table 3). The reduction rate also not different between conventional (45.41±28.80%) and minimal TLIF (32.91±32.12%, p=0.318). No neurologic complications were encountered. There were no signs of instrumentation failure and no visible subsidence of the cages until 12 months follow-up periods. All patients had their symptoms significantly improved, and the VAS decreased from 7.00±2.69 before operation to 3.11±1.86 at 12 months after operation in conventional TLIF, and from 7.14±3.15 before operation to 3.52±2.24 at 12 months after operation in minimal TLIF (Table 3). The clinical outcome was not correlated with reduction rate (p=0.341).

DISCUSSION

The advent of minimally invasive surgery had provided surgeons new techniques for treating clinical disease. Minimally invasive spine surgery aims to reduce approach related morbidity, while producing clinical outcomes comparable to its open predecessors. One important example of this is the development of minimally invasive techniques for lumbar interbody fusion, including TLIF. The minimal invasive TLIF technique, has displayed comparable outcomes to conventional TLIF, while adding the benefits of less approach related mor-
Spondylolisthesis Reduction in Conventional and Minimal TLIF

Conventional TLIF shows excellent slip reduction in patients with one level low-grade symptomatic isthmic spondylolisthesis. The slip percentage and reduction rate were similar in the conventional and minimal TLIF.

CONCLUSION

The conventional and minimal TLIF showed excellent slip reduction in patients with one level low-grade symptomatic isthmic spondylolisthesis. The slip percentage and reduction rate were similar in the conventional and minimal TLIF.
Dj: Spondylolysis and Spondylolisthesis: prevalence and association with low back pain in the adult community-based population. Spine (Phila Pa 1976) 34:199-206, 2009
6. Kwon BK, Berta S, Daffner SD, Vaccaro AR, Hilibrand AS, Grauer JN, et al: Radiographic analysis of transforaminal lumbar interbody fusion for the treatment of adult isthmic spondylolisthesis. J Spinal Disord Tech 16:469-476, 2003
7. Lee KH, Yue WM, Yeo W, Soeharno H, Tan SB: Clinical and radiological outcomes of open versus minimally invasive transforaminal lumbar interbody fusion. Eur Spine J 21:2265-2270, 2012
8. Lee SH, Choi WG, Lim SR, Kang HY, Shin SW: Minimally invasive anterior lumbar interbody fusion followed by percutaneous pedicle screw fixation for isthmic spondylolisthesis. Spine J 4:644-649, 2004
9. Lee YG, Cha JH, Park JS: Clinical outcome of minimally invasive tubular retractor assisted microscopic discectomy in far lateral lumbar disc herniation. Korean J Spine 7:155-160, 2010
10. Liang B, Yin G, Zhao J, Li N, Hu Z: Surgical treatment of degenerative lumbar instability by minimally invasive transforaminal lumbar interbody fusion [abstract only]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 25:1449-1454, 2011
11. McGirt MJ, Parker SL, Lerner J, Engelhart L, Knight T, Wang MY: Comparative analysis of perioperative surgical site infection after minimally invasive versus open posterior/transforaminal lumbar interbody fusion: analysis of hospital billing and discharge data from 5,170 patients. J Neurosurg Spine 14:771-778, 2011
12. Molinari RW, Sloboda JF, Arrington EC: Low-grade isthmic spondylolisthesis treated with instrumented posterior lumbar interbody fusion in US servicemen. J Spinal Disord Tech 18:S24-29, 2005
13. Pan J, Li L, Qian L, Zhou W, Tan J, Zou L, et al: Spontaneous slip reduction of low-grade isthmic spondylolisthesis following circumferential release via bilateral minimally invasive transforaminal lumbar interbody fusion: technical note and short-term outcome. Spine (Phila Pa 1976) 36:283-289, 2011
14. Recnik G, Košak R, Vengust R: Influencing segmental balance in isthmic spondylolisthesis using transforaminal lumbar interbody fusion. J Spinal Disord Tech 26:246-251, 2013
15. Suh KT, Park WW, Kim SJ, Cho HM, Lee JS, Lee JY: Posterior lumbar interbody fusion for adult isthmic spondylolisthesis: a comparison of fusion with one or two cages. J Bone Joint Surg Br 90:1352-6, 2008
16. Tsahtsarlis A, Wood M: Minimally invasive transforaminal lumbar interbody fusion and spondylolisthesis. J Clin Neurosci 19:858-861, 2012
17. Villavicencio AT, Burneikiene S, Nelson EL, Balsara KR, Favors M, Thramann J: Safety of transforaminal lumbar interbody fusion and intervertebral recombinant human bone morphogenetic protein-2. J Neurosurg Spine 3:436-444, 2005
18. Wang J, Zhou Y, Feng Zhang Z, Qing Li C, Jie Zheng W, Liu J: Comparison of clinical outcome in overweight or obese patients after minimally invasive versus open transforaminal lumbar interbody fusion. J Spinal Disord Tech [Epub ahead of print], 2012
19. Wang J, Zhou Y, Zhang ZF, Li CQ, Ren XJ, Chu TW, et al: Clinical study on lumbar spondylolisthesis treated by minimally invasive transforaminal lumbar interbody fusion [abstract only]. Zhonghua Wai Ke Za Zhi 49:1076-1080, 2011
20. Yan DL, Pei FX, Li J, Soo CL: Comparative study of PILF and TLIF treatment in adult degenerative spondylolisthesis. Eur Spine J 17:1311-1316, 2008