Interbody fusion cage implantation and bilateral inferior articular process resection for the treatment of degenerative lumbar spinal stenosis☆

Cao Jun-ming, Zhang Di, Shen Yong, Zhang Ying-ze, Ding Wen-yuan, Yang Da-long, Xu Jia-xin

Department of Spinal Surgery, Third Hospital of Hebei Medical University, Shijiazhuang 050051, Hebei Province, China

Cao Jun-ming☆, Studying for doctorate, Department of Spinal Surgery, Third Hospital of Hebei Medical University, Shijiazhuang 050051, Hebei Province, China caojunming2001@126.com

Correspondence to: Shen Yong, Professor, Chief physician, Doctor's supervisor, Department of Spinal Surgery, Third Hospital of Hebei Medical University, Shijiazhuang 050051, Hebei Province, China

Received: 2009-12-28
Accepted: 2010-02-02
(20091228017/GW)

Cao JM, Zhang D, Shen Y, Zhang YZ, Ding WY, Yang DL, Xu JX.Interbody fusion cage implantation and bilateral inferior articular process resection for the treatment of degenerative lumbar spinal stenosis. Zhongguo Zuzhi Gongcheng Yanjiu yu Linchuang Kangfu. 2010;14(17): 3226-3230.

[http://www.crter.cn http://en.zglckf.com]

Abstract

BACKGROUND: Degenerative lumbar spinal stenosis could be treated by laminectomy internal fixation placement, unilateral or bilateral decompression, posterior laminectomy and so on. However, whether laminectomy internal fixation placement can be used remains unclear.

OBJECTIVE: To evaluate the efficacy of interbody fusion cage implantation of pedicle screw fixation, in combination with posterior lumbar laminectomy, bilateral resection and decompression of the inferior articular process, autologous facet joint bone transplantation in the treatment of degenerative lumbar spinal stenosis.

METHODS: A total of 41 patients of degenerative lumbar spinal stenosis, who failed after 3 months of conservative therapy, including 23 males and 18 females, at a mean of 60.3 years, received posterior lumbar laminectomy, bilateral inferior articular process resection and decompression, autologous facet joint bone and cage interbody fusion implant pedicle fixation. They were followed up for 24 months, preoperative and postoperative Japanese Orthopedic Association (JOA) score evaluations were performed to assess the therapeutic efficacy of the patients, radiological examination was done to investigate the graft fusion and vertebral stability of surgical segments in patients.

RESULTS AND CONCLUSION: During the follow-up, JOA score significantly increased compared with the preoperative score ($P < 0.01$) and clinical excellence rate was 90%; 40 cases obtained bony fusion, with a fusion rate of 98%, 1 patient exhibited signs of lumbar instability. There was no loosening, fracture and other complications after internal fixation, but 2 cases appeared dural tear, 1 case pedicle position deviation, 1 case pseudoarticulation formation. The results suggest that the posterior lumbar laminectomy, bilateral inferior articular process resection and decompression, autogenous facet joint bone and cage interbody fusion implanted pedicle screw fixation show good clinical effects for the treatment of degenerative lumbar spinal stenosis.

INTRODUCTION

Degenerative lumbar spinal stenosis accounts for about 97% of lumbar spinal stenosis[1], mainly due to spinal degenerative changes increasing with age, causing abnormal activity between adjacent vertebral body, lumbar spinal canal therefore occurred bony and fibrous structural abnormalities, dural sac and nerve root compression arises a series of syndromes such as lumbago and lower extremity pain. In severe cases, surgical decompression is a commonly used and effective clinical treatment.

The surgical methods of degenerative lumbar spinal stenosis are unilateral or bilateral decompression, posterior laminectomy and decompression, whole laminectomy and internal fixation, *etc*. However, whether interbody fusion implant internal fixation is necessary in surgical treatment are still inconclusive.

From January to December in 2007, 41 patients of degenerative lumbar spinal stenosis achieved good therapeutic effects by use of posterior lumbar laminectomy and bilateral inferior articular process resection and decompression, autogenous facet joint bone and interbody fusion cage implant placement of pedicle fixation during the follow-up.

SUBJECTS AND METHODS

Design

Retrospective follow-up case analysis.

Time and setting

The experiment was performed between September and December in 2007 at the Third Hospital of Hebei Medical University.

Participants

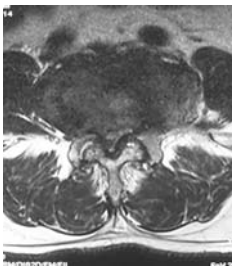
Totally 41 patients, 23 males and 18 females, were included. They aged 60.3 (45–71) years old. Duration of the disease was from 20 months to 15 years, at an average of 3 years and 5 months.

Inclusion criteria

Intermittent claudication, lumbago, hip and low limb radiating pain or feeling abnormal, and symptoms severe due to standing, walking or stretching the waist, combined with lumbar MRI imaging examination, consistent with the diagnosis of lumbar spinal stenosis; had no significant improvement of symptoms after more than 3 months of regular conservative treatment. Among 41 patients, 26 cases were accompanied with unilateral lower limb pain and swelling sense, 15 cases with bilateral lower limb pain and swelling sense, 21 cases positive for straight-leg raising test (16 cases of unilateral, 5 cases of bilateral), 3 cases with perineal numbness and difficulties in urinating, 6 cases with lower limb weakness and muscle atrophy; 19 cases of L_5 and S_1 nerve sensory disturbance, 16 cases of Achilles tendon reflex abnormalities, 25 cases of ipsilateral first toe of extending muscle strength weakening, 13 cases of plantar flexor strength weakening. The

stenotic lesions of a single segment were seen in 28 cases, of which 19 cases of L_{4-5} (Figure 1) and 9 cases of L_5-S_1; double segments in 12 cases, in which 3 cases of L_{3-4} and L_{4-5}, 9 cases of L_{4-5} and L_5-S_1; three segments stenosis of L_{3-4}, L_{4-5}, L_5-S_1 in 1 case; 29 cases exhibited lumbar instability. All patients understand the surgical treatment program and agreed to surgery.

a: Sagittal section showing L_{4-5} spinal canal stenosis, intervertebral height lowering



b: Cross-section showing L_{4-5} spinal canal stenosis, inferior articular process hyperplasia and cohesion, ligamenta flava hyperplasia and hypertrophy, bilateral nerve root canal stenosis

c: Cross-section showing L_{4-5} spinal stenosis, inferior articular process hyperplasia and cohesion, ligamenta flava hyperplasia and ossification, bilateral nerve root canal stenosis

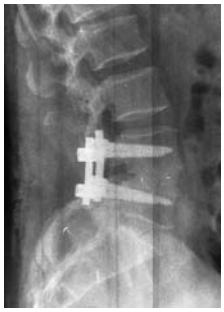
Figure 1 Preoperative lumbar spine MRI examination results at the sagittal and cross-sectional levels

Internal fixation materials: Moss Miami spinal cord system (Johnson & Johnson, USA) and interbody fusion cage (Cage) in 15 cases; pedicle screw-rod system (Beijing Fule Science and Technology Development Co., Ltd., China) and interbody fusion (Cage, Abbott Spine, French) in 26 cases.

Surgical methods

Continuous epidural anesthesia or general anesthesia, in a prone position, regular exposure to spinous process and bilateral upper and lower vertebral articular process at the lesion, intraoperative X-ray guidance of pedicle screw placement, removal of spinous process, lamina and inferior articular process joints at the lesion, and expansion of nerve root canal, loosening the compressed nerve root, in the protection of epidural and nerve root, complete removal of intervertebral disc and cartilage end-plate, retaining the bony end-plate, using the resected lamina and articular process bone, trimmed into small granules and then implanted in front of and both sides of the intervertebral space, and obliquely implanted with one interbody fusion cage (cage), which was far away from the posterior edge of the spinal canal for about 1.5 mm (Figure 2), the autologous superficial fascia was harvested to cover the exposed epidural. Hemostatic gelatin sponge, negative pressure drainage, incision inclosure were perpormed.

a: Preoperative intervertebral height reduction



b: Satisfactory interbody fusion and internal fixation location, without loosening or fracture

Figure 2 Preoperative and postoperative 24-month L_{4-5} X-ray films at lateral view

Postoperative treatment

All patients received routine use of antibiotics at 3 days postoperation, removal of stitches at 10–12 days, lying in bed for 4–6 weeks, get out of bed under waist circumference protection, avoided moving heavy objects within 3 months. At postoperative 1 week, 6, 12, 24 months, respectively, the patients were visited and should be shot in antro-posterior and lateral lumbar X-ray films at every follow-up, some patients with lumbar dynamic digital X-ray examination to analyze graft fusion, lumbar stability and symptom improvement after operation.

Efficacy evaluation criteria

Clinical symptoms were evaluated by Japanese Orthopedic Association (JOA) score standards for low back pain, preoperative score was recorded according to medical records of patients and in the follow-up after operation, total score was 29 points. The higher the score, the less the symptoms, the lower the functional disorder; the lower the score, the more serious the symptoms, the more severe the functional

impairment.

Nahal classification criteria for grading operation results
The criteria are as follows: excellent: intermittent claudication, low back pain and other symptoms disappeared completely, returning to work; Good: the symptoms disappeared, but the mild low back pain occurred after exertion, does not affect the work; Fair: low back pain still existed after surgery, lower limb muscle strength and bladder sphincter function can not return to normal, but has improved compared with before surgery; Poor: no improvement in symptoms after surgery.

Graft fusion and the vertebral stability of surgical segments
The interbody fusion was assessed according to the following criteria[2]: a strong fusion, continuous trabecular bone crossed the fused segments, the relative activities was less than 4° between segments at the dynamic view; possible fusion, there was no continuous trabecular bone on the fused segments, but the relative activities was less than 4° between segments at the dynamic view; non-fusion, there were obvious gaps on the fused segments, the relative activities was more than 4° between segments at the dynamic view. For the possible fused patients, CT examination was performed to further determine fusion.
The lumbar dynamic X-ray film (hyperextension, hyperflexion, left and right lateral flexion), lumbar segmental instability was considered as $\geqslant$ 3 mm displacement of adjacent vertebral bodies in any direction.

Main outcome measurement
The surgical curative effect, graft fusion and vertebral stability of surgical segments.

Design, enforcement and evaluation
This study was designed by the third and fourth authors, the operation was implemented by the third, fifth, sixth authors, the patients were evaluation by the first, second, seven authors before and after surgery.

Statistical analysis
Using SPSS11.5 software package, data was analyzed by *t*-test, a level of $P < 0.05$ was considered as statistical significance. Statistical analysis was performed by the first and second authors.

RESULTS

Follow-up results
All patients were followed up for 24 months and 41 patients entered the final analysis.

JOA score
The average preoperative JOA score was (11.79±2.13) points, postoperative follow-up average score was (25.83±3.77) points, with statistically significant difference ($t = 21.018$, $P < 0.01$). Among them, there were excellent in 26 cases, good in 11 cases, fair in 4 cases; clinical excellent and good rate was 90%.

Graft fusion
According to Suk's method, the fusion was determined, 40 cases obtained bony fusion during follow-up (Figure 3), with a fusion rate of 98%. 1 patient exhibited no bone fusion, formed pseudoarthrosis, without significant discomfort nor affection on daily life, he received conservative treatment such as external fixation through wearing waist, for further close observation. At the end of follow-up, one case without bone fusion exhibited unstable vertebral segment (2%), while the rest patients had no lumbar instability.

Figure 3 Orthotopic X-ray films showed a good internal fixation position, without loosening or fracture in L_{4-5} spinal stenosis 24 months after surgery

Adverse events
During surgery, two cases of spinal dural tear had been repaired, cerebrospinal fluid leakage or other discomforts did not occur after surgery; one case with sustained nerve root irritation had been inspected and confirmed by postoperative CT films as a pedicle screw location inclined to the inner side, the symptoms were obviously alleviated at 3 months after conservative treatment, there was only a partial numbness. No postoperative internal fixation loosening, fracture and other complications occurred.

DISCUSSION

Characteristics of degenerative lumbar spinal stenosis
Degenerative lumbar spinal stenosis is common in middle-aged and age populations, it exhibits slow onset and long course of the disease, the most common symptoms were intermittent claudication and standing discomfort, become severe after tiredness and turn to ease with a break. Facet process hypertrophy and cohesion, laminar thickness, thickening and ossification of posterior longitudinal ligament and ligamentum flavum, disc degeneration, posterior edge hyperplasia and ossification, as well as osteophyte formation, which are often the cause of degenerative lumbar spinal stenosis and always accompanied with degenerative lumbar instability. The natural course of disease is poor, those who fail to regular conservative treatment, are suggested to receive surgical treatment as early as possible[1].

Surgical treatment of degenerative lumbar spinal stenosis
The majority of scholars think that the partial decompression is predominant, surgical decompression is only given to the affected side, whereas the opposite remains unchanged[3-5]; Liao *et al*[6] and Ruan *et al*[7] believe that: as for the stenosis is clear in imaging examination but only one lesion side of the clinical symptoms, the patients should routinely perform bilateral symmetrical decompression in order to avoid a

second operation; and traditional laminectomy spinal decompression often destroy the stable structure of the spinal canal to different degrees, thus affecting the stability of the lumbar spine or severe the instability of original structure was already unstable, which is one of the important reasons for the poor effect of lumbar spine surgery[8-9].

To maintain the stability of the postoperative spinal cord is the key of lumbar spinal stenosis surgical treatment. Yu *et al*[10] arise that the lumbar instability is one of the reasons for poor efficacy of degenerative lumbar spinal canal stenosis, at the same time of surgical decompression, the stability of the lumbar spine should also be restored, while the internal fixation fusion is particularly necessary for the prevention of iatrogenic loss of stability. The long-term efficacy of degenerative lumbar spinal stenosis surgery and secondary lumbar instability have resulted in continuous low back pain and disc herniation[11]. Javid *et al*[12] have followed up 86 cases of lumbar spinal canal stenosis after surgical decompression, the rate of satisfaction effect was 88% at 6 weeks after surgery, while 71% at 5-year follow-up. Silvers *et al*[13] summed up the excellent and good effect rate of lumbar spinal canal stenosis patients was 90% at post-operative 1 year and only 67% at 5 years. Graft fusion is an important measure to the original and postoperative instability in lumbar spine, especially for the widely used decompression, bone fusion is an important measure to maintain the efficacy. Most scholars believe that the fusion internal fixation is suggested if there is an instability, the advantage is to improve the fusion rate, restore intervertebral height, correct deformity, immediately stabilize the spine, induce early postoperative ambulation[3-5]. Biomechanical and clinical studies have shown that interbody fusion applied in spinal fusion can enhance the stability of the surgical segment, restore intervertebral height, while promoting a strong fusion[14-15]. Hai *et al*[16] applied lumbar lateral and rear oblique single pieces of BAK interbody fusion cage and the facet screw fixation in the treatment of lumbar degenerative segmental instability and nerve root canal stenosis, under the premise of full decompression, it could maintain the stability of the spine, while complete graft fusion, recent follow-up shows positive clinical efficacy. Zdeblick[17] observed a group of patients with degenerative lumbar spinal diseases and underwent lumbar fusion, results found that fusion rate and the corresponding clinical excellent and good effect rate were significantly higher in the internal fixation group than the non-internal fixation group. Booth *et al*[18] observed the fusion rate was 100%, mid-and late stage satisfaction rate of 83%. In the present study, patients underwent decompression laminectomy, interbody fusion and internal fixation, they can get up and do some activities internal fixation, avoiding post-operative complications caused by long-term bed rest, with a follow-up of 36.5 months, bone fusion rate of 97.56%, rate of excellent and good clinical quality of 90.24%; except 1 patient (2.44%) without bone fusion exhibited lumbar instability, the rest did not have signs of lumbar instability.

Role of inferior articular process resection in degenerative lumbar spinal stenosis

The primary purpose of a thorough and effective decompression is to treat degenerative lumbar spinal stenosis and to relieve nerve compression, non-complete decompression could play a direct impact on surgical treatment efficacy. Surgical removal of small joints allow a wider field of vision, which is conducive to resect intervertebral disc, nerve root canal decompression provides more space for interbody graft. Hypertrophy and cohesion of facet joints, as well as ligamentum flavum hypertrophy can all induce lateral recess stenosis and nerve root canal stenosis, which may produce radioactive lower limb pain[19]. Degenerative lumbar spinal stenosis is mainly nerve root canal stenosis, the traditional PLIF surgery retains facet joints and often can not effectively and completely decompress the nerve root canal, thus leading to the continued existence of postoperative nerve root compression factor, is one of the main causes for the failed syndrome of lumbar surgery. Yu *et al*[10] believe that a incomplete decompression is one of the reasons of poor efficacy of degenerative lumbar spinal stenosis after operation, while a thorough decompression is the key to the treatment. Wang *et al*[11] also believe that the early reasons for poor efficacy of decompression is insufficient decompression caused invalid or early postoperative relapse, because patients are worried that excessive removal will lead to iatrogenic instability and reduce the decompression range. The patients were subjected to bilateral inferior articular joint resection, ensuring a thorough decompression, thereby avoiding the above situation. In addition, if sneak resection of ligamenta flava and some bone in the medial part of articular process underwent nerve root decompression, it is easy to damage the compressed and swelled nerve root; after the bilateral inferior articular joint resection, lateral recess can be fully extended, nerve root decompression may be through their shoulder and lateral spinal canal such as a more broad perspective, and to reduce the chances of nerve root injury, so that decompression is more safe. Biomechanical studies[20] have shown that, even if the bilateral facet joints have been removed, under the influence of the pedicle screw fixation system and cage implantation, it can provide adequate spinal stiffness for spinal functional units. In this study, patients received total laminectomy decompression, intraoperative resection of bilateral hyperplasia of the inferior articular process, so that a wider field of vision surgery is obtained, the decompression is more thorough, more complete, more safe; at the same time, autologous facet bone and vertebral cage interbody fusion implant pedicle screw fixation, based on the full decompression, could reconstruct and maintain the stability of the lumbar spine, and achieve a satisfactory clinical efficacy.

REFERENCES

[1] Liu RL. Lumbar spinal stenosis. Zhongguo Jiaoxing Waike Zazhi. 2004;12(19):1514-1516.
[2] Suk SI, Lee CK, Kim WJ, et al. Adding posterior lumbar interbody fusion to pedicle screw fixation and posterolateral fusion after decompression in spondylolytic spondylolisthesis Spine (Phila Pa 1976).1997;22(2):210-220.
[3] Xu HG, Wang YP, Qiu GX. Surgical treatment of degenerative lumbar spinal stenosis. Zhonghua Waike Zazhi. 2002;40(4): 314-317.
[4] Jia LS, Yang LL. Contemporary surgery concept of degenerative lumbar spinal stenosis Zhonghua Guke Zazhi. 2002;22 (8):509-512.
[5] Zhao HY, Mei FR, Ye X, et al. Evaluation of surgical decompression and internal fixation for the treatment of lumbar spinal stenosis: a clinical analysis of 259 cases. Zhongguo Jizhu Jisui Zazhi. 2003;13(1):18-21.

[6] Liao WB, Hong S, Peng JC, et al. Surgical methode of lumbar spinal stenosis. Zhongguo Gu yu Guanjie Sunshang Zazhi. 2005;20(7):472-473.
[7] Ruan DK, He Q, Wang PJ, et al. Long-term outcome of multiple laminectomy for lumbar spinal stenosis. Shiyong Guke Zazhi. 2005;11(6):487-489.
[8] Wang YT, Chen ZH, Li M, et al. Extcnsive plasty of the lumbar canal: clinical appl ication of lalnina osteotomy replantation and spinous process replantation. Zhonghua Guke Zazhi. 1995; 15(10):643-647.
[9] Shi GH, Chen XM, Li H, et al. Laminoplasty for lumbar spinal stenosis: analysis of 30 cases. Jing Yao Tong Zazhi. 2000; 21(4):296-297.
[10] Yu W, Fei J, Yang JW, et al. The reasons of inefficacious surgical treatment of degenerative lumbar spinal stenosis. Zhongguo Gu yu Guanjie Sunshang Zazhi. 2002;17(4):293-294.
[11] Wang DY, Wen GH, Li M. Diagnosis,location and surgery of lumbar spinal stenosis. Jing Yao Tong Zazhi. 2005;26(4):288-290.
[12] Javid MJ, Hadar EJ. Long-term follow-up review of patients who underwent laminectomy for lumbar stenosis: a prospective study. J Neurosurg.1998;89(1):1.
[13] Silvers HR, Lewis PJ, Asch HL. Decompressive lumbar laminectomy for spinal stenosis. J Neurosurg.1993;78(5):695.
[14] Rapoff AJ, Ghanayem AJ, Zdeblick TA. Biomechanical comparison of posterior lumbar interbody fusion cages. Spine (Phila Pa 1976).1997;22(20):2375-2379.
[15] Ray CD. Threaded titanium cages for lumbar interbody fusions. Spine (Phila Pa 1976). 1997;22(6):667-679.
[16] Hai Y, Zou DW, Ma HS, et al. Surgical treatment of single level unstable degeneration with foraminal stenosis. Zhonghua Waike Zazhi. 2000;38(8):607-609.
[17] Zdeblick TA. A prospective, randomized study of lumbar fusion preliminary results. Spine (Phila Pa 1976).1993;18(8):983-991.
[18] Booth KC, Bridwell KH, Eisenberg BA, et al. Minimum 5-years results of degenerative spondilolisthesis treated with decompression and instrumented posterior fusion. Spine (Phila Pa 1976).1999;24(22):1721-1727.
[19] Jenis LG, An HS. Lumbar foraminal stenosis Spine. 2000,25(3): 389-394.
[20] Oda I, Aibum KY, Yu BS, et al. Types of spinal instability that require interbody support in posterior lumbar reconstruction: an in vitro biomechanical investigation. Spine (Phila Pa 1976). 2003;28(14):1573-1580.

椎间融合器植入并双侧下关节突切除治疗退变性腰椎管狭窄症☆

曹俊明，张　迪，申　勇，张英泽，丁文元，杨大龙，徐佳欣(河北医科大学第三医院脊柱外科，河北省石家庄市　050051)

曹俊明☆，男，1981 年生，汉族，山西省孝义市人，河北医科大学在读博士，主要从事脊柱外科研究。
通讯作者：申　勇，教授，主任医师，博士生导师，河北医科大学第三医院脊柱外科，河北省石家庄市　050051

摘要

背景：对退变性腰椎管狭窄治疗可行全椎板减压内固定置入、单侧或双侧开窗减压、后路全椎板减压等方法。但采取何种方式治疗中是否需行椎间融合器植入内固定目前还没有定论。

目的：评价以 cage 椎间植骨融合椎弓根内植入固定并腰后路全椎板及双侧下关节突切除减压、自体小关节骨质移植治疗退变性腰椎管狭窄症的效果。

方法：选择经 3 个月保守治疗无效的退变性腰椎管狭窄症患者 41 例，男 23 例，女 18 例，平均年龄 60.3 岁，行腰后路全椎板及双侧下关节突切除减压、自体小关节骨质及 cage 椎间植骨融合植入椎弓根内固定治疗，随访 24 个月，术前及术后随访时 JOA 评分评价患者疗效，放射学检查患者植骨融合情况及手术节段椎体稳定性。

结果与结论：随访时 JOA 评分较术前有明显提高($P < 0.01$)，临床优良率为 90%；40 例获得骨性融合，融合率 98%，1 例患者有腰椎不稳征象。术后均无内固定物松动、断裂等并发症发生，但有 2 例发生硬脊膜撕裂，1 例发生椎弓根位置偏斜，1 例假关节形成。结果提示腰后路全椎板及双侧下关节突切除减压、自体小关节骨质及 cage 椎间植骨融合植入椎弓根内固定治疗退变性腰椎管狭窄症具有良好的临床效果。

关键词：腰椎管狭窄症；退变；椎间融合；小关节；医学植入体
doi:10.3969/j.issn.1673-8225.2010.17.047
中图分类号: R318　文献标识码: B
文章编号: 1673-8225(2010)17-03226-05
曹俊明，张迪，申勇，张英泽，丁文元，杨大龙，徐佳欣.椎间融合器植入并双侧下关节突切除治疗退变性腰椎管狭窄症[J].中国组织工程研究与临床康复，2010，14(17): 3226-3230.
[http://www.crter.org　http://cn.zglckf.com]
(Edited by Pi GF/Yang Y/Wang L)