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Original Article

Comparison of decompression only versus posterior lumbar interbody fusion for lumbar nerve root canal stenosis in elderly patients

Chunyue Duan, Jianzhong Hu, Yong Cao, Xiyang Wang, Jianhuang Wu

Department of Spine Surgery, Xiangya Hospital, Central South University, No. 87 Xiangya Road, Changsha 410008, Hunan, China

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Abstract: Study design: A prospective series study. Objective: This study was conducted to compare the surgical, clinical, and radiologic outcomes of decompression only versus posterior lumbar interbody fusion (PLIF) in patients older than 65 years with symptomatic one or two-level lumbar nerve root canal stenosis. Methods: During the period of 2009 to 2014, 95 elderly patients (65 years or older) who suffered from one or two-level lumbar nerve root canal stenosis, consisting of radiculopathy or neurogenic claudication were enrolled in the study. Patients were allocated to two groups by surgical modality, a decompression group (42 patients) or a PLIF group (53 patients). In decompression group, enlargement of the nerve root canal was performed by undercutting osteophyte of the facet joint and hyperplasia of the ligament, while in fusion group, laminectomy combined with pedicle screw fixation and intervertebral fusion was performed. The surgical, clinical, radiologic outcomes of the two groups was analyzed at 6 and 12 months postoperatively. Results: Overall mean age was 71.1 years (range, 65-83) in decompression group, which was 68.3 years (range, 65-77) in fusion group. There was no significant difference between the two groups with respect to age, preoperative condition or surgical levels. Clinical outcomes were measured by a visual analogue scale (VAS) for leg pain and the Oswestry Disability Index (ODI) for functional recovery. The change of VAS and ODI were not significantly different between the two groups. Whereas the cost and surgical outcomes such as operation time, mean blood loss, and surgical complications were significantly better in decompression group. Overall intraoperative and postoperative complications occurred in 3 patients (7.1%) at decompression group while in 8 patients (15.1%) at PLIF group ($P<0.05$). According to late complications, 2 patients (4.8%) developed in decompression group, while 5 patients (9.4%) developed in PLIF group ($P<0.05$). Conclusions: For elderly patients suffered from one or two-level lumbar nerve root canal stenosis, decompression the canal alone could achieves the similar clinical outcomes with PLIF in one year after surgery, while the cost and surgical outcomes will be better. It is less invasive procedure and effective in treating the nerve root canal stenosis.

Keywords: Decompression, PLIF, nerve root canal stenosis, elderly patients

Introduction

Lumbar spinal stenosis (LSS) is one of the most commonly pathological spinal conditions. It frequently afflicts the elderly population aged over 65 years [1]. The nerve root canal (lateral recess) is one of the main compression sites in LSS. Narrowing of the nerve root canal presses on the spinal nerves, causing inflammation and leg pain which may cause loss of function and inability to perform basic daily activities [2].

For patients with severe nerve root canal stenosis or resistant to conservative treatment, operation has been the treatment of choice and will gives significantly more improvement results [3]. The principal goal of the surgery was decompression, but if extensive procedures of decompression not combined with fixation and fusion, the incidence of motion-induced discogenic pain and biomechanically instability might occur. However, decompression combined with fixation and fusion might result in greater intraoperative blood loss, longer operative time, hardware failure or non-union. Because of the general medical condition and associated medical problems, elderly patients are less able to tolerate major surgery. Which surgical tech-

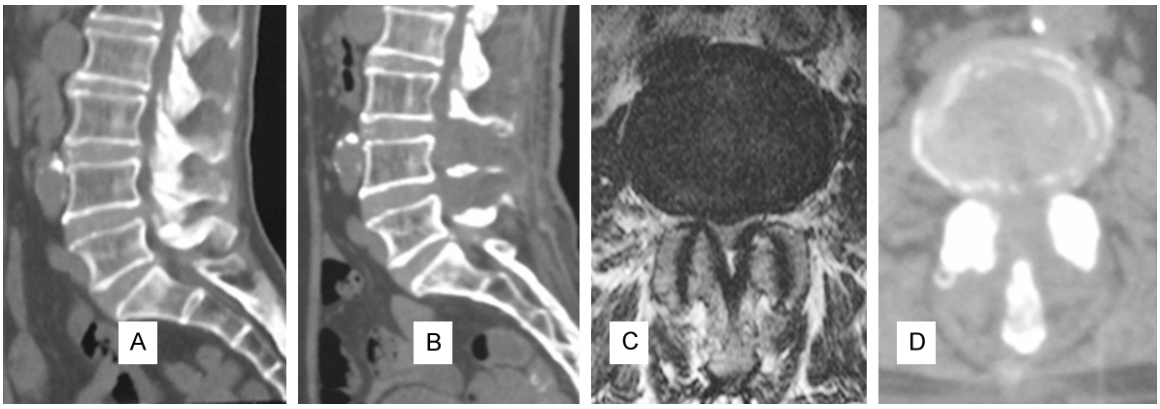

Figure 1. Typical case. 75 years female patient, complained with both leg pain and numbness for 5 month. Diagnosed with L4/5 L5S1 both side nerve root canal stenosis. Patient underwent posterior nerve root canal enlargement at both side of L4/5 and L5S1, (A, B) Show the preoperative and postoperative sagittal view image, (C, D) Show preoperative and postoperative image of L4/5.

nique is the better choice has been a historic conflict. Accordingly, the purpose of the current study was to analyze the surgical, clinical, and radiologic outcomes following decompression alone or PLIF in elderly patients with lumbar nerve root canal stenosis.

Patients

Written informed consent was obtained from all patients, and this study protocol was approved by the Ethics Committee of Xiangya Hospital. From January 2009 to December 2013, 95 patients were selected for this study. The inclusion criteria were as follows: (1) aged 65 years or older, (2) lumbar nerve root canal stenosis on CT or MR images, one or two level affected, (3) clinical manifestations include radicular pain, weakness, or sensory loss referable to structures innervated by the involved nerve root, (4) refractory to non-surgical treatment, which included analgesia, bed rest, physiotherapy or manipulations, (5) followed-up periodically for 12 months. The exclusion criteria were as follows: (1) patients who had central canal stenosis, severe lumbar disc herniation, spinal abscess, osteomyelitis, neoplasm, or fracture-dislocation, (2) not followed-up for 12 months after surgery, (3) deceased at the time of the follow-up. (3) underwent revision surgery or deformity correction, (4) combined with degenerative scoliosis more than 30°.

According to surgical technique, 95 patients were divided into two groups. Of the 42 patients, were allocated to the decompression group, and 53 to the PLIF group. All the charts and records were reviewed at 6 and 12 months after surgery.

Surgical technique

In cases of decompression group, operations were carried out under general anaesthesia. The spinal canal was opened by a laminotomy fenestration and the exploration was then carried laterally. A Kerrison's rongeur was used to remove part of the bone from the medial of the pars so as to open part of the roof canal. The nerve root and the direction of the root canal was then identified by gentle probing. The initial cut was made using a 10-millimetre osteotome which was advanced in an oblique direction, roughly parallel to the longitudinal axis of the spinal canal. In order to reduce the risk of sudden uncontrolled advance, the osteotome was advanced with the percussion effect of rapid light blows. In the same careful manner, a kerrison rongeur was then used to undercut the superior articular process, which was causing compression. It was also important to remove the ligamentum flavum by undercutting of more bone from the lamina of the uppermost vertebra because it may contributed to compression in the root canal. At the end of the procedure the nerve root should lie freely through the root canal from its origin at the dural sac to its passage out through the intervertebral foramen. There was often a small bulge due to an old degenerate disc, it was not usually operated unless partial facetectomy has failed to provide an adequate decompression. In cases of fusion, the standard bilateral laminectomy and decompressive ligamentectomy were per-

Table 1. Summary of demographic data of both groups

Variable	Decompression group	Fusion group	*P*-value
Number of patients	42	53	
Mean age (years)	71.1±5.3	68.3±6.9	0.551
Male sex ratio (%)	56.6	62.3	0.311
Number of levels of operation			0.692
1 level	32	31	
2 levels	10	22	
Levels of operation			0.461
L3-4	4	5	
L4-5	21	38	
L5-S1	27	32	

formed at each symptomatic stenotic level, discectomy and foraminotomy were also performed. After the procedure of decompression, posterior lumbar interbody fusion (PLIF) followed by transpedicular screw fixation was performed (**Figure 1**).

Outcome parameters

Surgical outcomes were compared with respect to operation times, mean blood loss and the length of the hospital stay. The occurrences of perioperative morbidities and complications were also reviewed. Clinical outcomes were assessed using a visual analogue scale (VAS) leg pain, the Oswestry Disability Index (ODI) for functional recovery, the mean VAS and ODI scores were evaluated at 6 and 12 months compared with that before surgery. VAS scores were determined using 0 to 10 point scales, where a score of 0 means symptom-free, and a score of 10 means the most serious symptom. Radiographs outcomes were examined by taking standard anterior-posterior, lateral, flexion-extension lateral radiographs and MRI or CT scan of the lumbar spine preoperatively and during follow-up for patients. Radiographic adjacent segment degeneration (ASD) were diagnosed when there was >75% disc space narrowing, large spur formation, olisthesis or translation ≥5 mm at the disc level adjacent to the fused segments [4] or when there were symptoms of spinal stenosis (neurogenic claudication or radiculopathy) referable to the adjacent segment [5].

Analysis

Each of the clinical outcomes was analyzed individually. SPSS version 18.0 (SPSS Inc., Chicago, IL, USA) was used to analyze all data. The chi square test, the independent 2-sample t-test, and the one-way analysis of variance were used depending on the characteristics of the variables being compared. Statistical significance was accepted for *P* values of <0.05.

Results

A total of 42 patients (44.2%) were treated with decompression alone and 53 (55.8%) had combined with fixation and fusion. Mean age was 71.1 years (range 65-83 years) in the decompression group (D) and 68.3 years (range 65-77 years). In the PLIF group (F). No significant intergroup difference was found with respect to age, sex ratio or surgical levels (**Table 1**). The mean blood loss of the D group and the F group was 156.6 ml and 478.3 ml, respectively (P<0.01). The mean surgical time was 77.5 minutes and 135.6 minutes, respectively (P<0.01). The mean length of hospital stay was 5.3 days for patients at D group and 14.9 days when fusion was performed (P<0.05). In both groups, VAS for leg pain was decreased during follow-up, sequentially. The leg pain VAS scores were initially 5.2 and 6.1 in D and F group respectively. It improve to 2.3 and 31, respectively at 6 months (P<0.05), to 1.2 and 2.3 at 12 months (P>0.05) after surgery. There was no significantly different improvement between the two groups (P>0.05). The functional aspects were evaluated using ODI scores. In both groups, ODI decreased during follow-up, sequentially (P<0.05). The ODI score for the D group decreased from 22.0 to 8.3 at 6 months and decreased to 7.9 at 12 months. The F group followed a similar trend (26.7 → 9.2 → 8.1). The decrement of ODI over time was significant (P<0.01). However, ODI scores were not significantly different in two groups.

Overall intraoperative and postoperative complications occurred in 3 patients (7.1%) at D group (2 CSF leakage, 1 Wound infection) while in 8 patients (15%) at F group (3 Wound infection, 2 CSF leakage, 1 Renal failure, 2 Urinary tract infection) (P<0.05). No patients died in the hospital or during the immediate postoperative period. According to late complications, in D group, 2 patients (4.7%) developed

late complications (1 recurrence, 1 instability), In F group, 5 patients (9.4%) developed late complications (3 subsidence, 2 screw loosening, 2 non-union, and 4 ASD) Although late complications were more frequent in the F group, it is not reasonable to compare the late complication rate between two groups because the items of complications are different.

Discussion

As the average age of the general population increases, lumbar spinal stenosis (LSS) has already been the most common indication for spinal surgery in patients aged over 65 years [6]. LSS is defined as a narrowing of the spinal canal that produces compression of the neural elements. The lumbar canal can be divided into three zones [7]: the central, nerve root canal, and the neuroforamen. In younger patients, prolapse of an intervertebral disc is more often seen which could lead to central spinal stenosis. While in patients over 50 years of age, there is increasing evidence [8] that "arthritis" of the facet joints is a common cause of backache and sciatica. Spine surgeons are being increasingly confronted with older patients suffering from LSS caused by degenerative changes of the facet joint. For patients who were ineffective by conservative treatment, decompression of the neural elements by surgery such as laminectomy has been the treatment of choice. It is important that the whole length of the facetal joint complex is adequately decompressed. However, a standard wide decompressive involves removal of the lamina and ligamentum flavum from the lateral border of one lateral recess to that of the other at all involved spinal levels, which will induce to unstable of the lumbar spine. Several authors [9-11] have noticed that patients with spinal stenosis usually suffered from instability after decompression, and decompression without fusion might led to a higher rate of recurrence of stenotic symptoms. Some clinical studies suggested that decompression should be accompanied by fusion, otherwise the patients will provoke lumbar instability and aggravate symptoms after surgery [12].

Whereas, others studies have questioned this, Iguchi [13] suggest the effect of spinal instability on the outcome following decompression is less favorable with a post-operative slip. Furthermore, the addition of fusion can lead to an increased risk of life threatening complications [14] and a higher mortality rate [15], especially for the elderly patients with a high incidence of comorbidities. In elderly patients, pedicle screw fixation and interbody fusion could also has significant adverse events, cause instrument-related complications, such as postoperative complications, instrument failure, and adjacent segment degeneration (ASD) [16]. In patients with osteoporosis, transpedicular screw fixation or interbody fusion can also result in subsidence, screw failure, or nonunion. Phillips [17] reported that the increasing use of instrumentation was correlated with the raising of mortality, the risk of complication and reoperation. Pellise [18] showed that fixation could only improve the daily activities of the patients, but could not help to get better clinical outcomes. In addition to this, the debate about the cost-effective also still exist.

As these elderly patients might be at increased risk for complications because of their age and associated medical conditions [19], the appropriate surgical technique remains controversial. Decompression alone could preserves spinal stability since the facet joints are not totally destroyed and the pars interarticularis is preserved. This technique has been adopted by many surgeons. Son et al [20] reported that decompressive surgery alone produces good results in spinal stenosis, Ragab [2] also showed that old age with decompressive surgery alone in lumbar spinal stenosis could get good results and does not increase morbidity associated. For older patients, decompressive laminectomy alone could minimize tissue injuries, shorten operation times, reduce perioperative morbidity, and prevent instrument-related complications. In the present study, we observed postoperative improvement of clinical outcome in leg pain and ODI scores, and there were no significant difference between the two groups. The changes in leg pain in both groups had similar patterns. The ODI in both groups also showed similar results. In decompression only group, as the technique is a partial facetectomy and preserves spinal stability, the pars interarticularis is preserved and no patient in this series has developed spondylolisthesis acquisita. Grob et al [21] also reported no differences between decompression or decompression and fusion in outcomes at a mean follow up of 28 months. Mannion [22] examined the out-

comes of lumbar decompression surgery without fusion, found pain and disability showed minimal change in the 5-year period after surgery. Niggemeyer et al [23] reported the similar findings in a meta-analysis by including 1668 patients with a mean follow-up of 4.7 years.

Different surgical technique, such as decompression alone or fusion, has their own unique advantages and disadvantages [24, 25]. Knaub suggested that [26] relative indications for the use of spinal instrumentation in the setting of spinal stenosis include correction of deformity, recurrent spinal stenosis with instability, degenerative spondylolisthesis, adjacent segment stenosis with instability, and multiple level fusions.

In this series, patients mainly suffered form radicular pain, weakness, or sensory loss referable to structures innervated by the involved nerve root. For these patients, nerve decompression should be the first key point. The nerve root canal is the area between the lateral border of the dural sac along the median and a longitudinal line connecting the medial walls of the pedicles laterally, stenosis osteophytic enlargement of this zone affects the traversing spinal nerve root. Radiculopathy associated with a stenotic nerve root canal is well recognized [27]. In nerve root canal stenosis, the spinal nerve may be entrapped at three different zones. Entrance zone stenosis is caused by the hypertrophic osteoarthritis of the facet joint particularly especially the superior articular process, mid zone stenosis caused by localized bony hypertrophy or hyperplastic ligamentum flavum under the par, exit zone stenosis usually because of the hypertrophic osteoarthritis changes of the facet joints and osteophytic ridge formation along the superior margin of the disc. Successful results of surgical decompression of nerve root canal stenosis will depend on understanding the precise locations and types of pathologic conditions and on application of appropriate surgical decompression techniques for each zone. Surgical management consists of decompressing the nerve root emerging from the thecal sac along its entire course in the radicular canal with laminotomy and medial facetectomy. This achieves satisfactory decompression. If lumbar disc herniation accompanies the pathology, removal of disc material is needed additionally [28].

What degree the facetectomy must be performed is uncertain. The suggested amount of medial facetectomy is ranging from one-third to one-half [29]. The lateral attachments of the ligamentum flavum are also play an important role to the stenosis, this portion also should be carefully removed by undercutting of the pars interarticularis. The medial wall of the pedicle is usually used to identify the lateral extent of central and lateral recess decompression. This is a reliable method to ensure adequate decompression. In addition, it maintains an appropriate amount of the pars interarticularis, thereby preventing the possibility of an iatrogenic pars fracture [7]. The use of instrument in the narrow canal space is positively dangerous. In order to reduce the risk of sudden uncontrolled advance, the osteotome is advanced with the percussion effect of rapid light blows. At no stage in this operation should the fragments be forcibly pulled out by Kerrison's rongeur or damage may be done to the underlying nerve. Provided that the root is identified where it arises from the dural sac and the described precautions are taken, the root will not be damaged.

For the patients of advanced age, surgeons must pay attention to the procedure of the surgery (i.e. control of blood loss and limitation of operative time) and be vigilant about perioperative complications. Many studies have emphasized the morbidity associated with surgical treatment of lumbar stenosis in the elderly population. It is reported that [14], with increasing surgical invasiveness, the life-threatening complications increased from 2.3% among patients underwent decompression alone to 5.6% among those having complex fusions. In our study, the patients in decompression group show better results than that in fusion group at the respect of blood loss, surgical time and the length of hospital stay, while the complication occurred less than the fusion group. According to the high rate of complication, treating older patients with the least invasive procedure should be the main goals of the surgery. It is believed that not all of the patient underwent decompression need to combined with fusion, the selection of fusion depends on numerous factors, such as, symptoms, age, general condition, the presence of osteoporosis, the number of segments involved, the presence of instability, and surgeon's preference [30].

In this study, the patients enrolled mainly suffered form the nerve root canal stenosis, and the operative technique has been developed which allows decompression of the lateral part of the root canal by means of a partial undercutting facetetectomy, while preserving stability of the spine and the depth of the spinal canal. The surgical techniques directed to nerve root canal stenosis are in tendency of being less invasive compared to the fusion and fixation ones. The aim is to be less destructive when decompressing the stenotic area. Patients are therefore firmly told before operation that the procedure is designed to relieve symptoms in the leg, and that any reduction of backache is a bonus. The operation is not advised unless symptoms or signs in the leg are the predominant feature.

Conclusion

As this study shows, elderly patients may be at increased risk for complications because of their age and associated medical conditions. As no significant different were found in the near future between two group, we tend to treat older patients suffered from pure nerve root stenosis with decompression alone without fixation and fusion, which is the less invasive procedure. The technique is effective in treating the nerve root stenosis. Minimal bony defect averts prolonged postoperative pain and immobility, which are well depicted sequelae of extensive bony decompression.

Disclosure of conflict of interest

None.

Authors' contribution

CD participated in the design of this study and performed the statistical analysis. CD drafted the manuscript. XW and JH carried out the study, together with JW collected important background information. CD collect clinical data and follow-up details of this study, and YC participated in the design and helped to draft the manuscript. All authors read and approved the final manuscript.

Abbreviations

PLIF, Posterior lumbar interbody fusion; VAS, Visual analogue scale; ODI, Oswestry Disability Index; LSS, Lumbar spinal stenosis; CT, Computerized Tomography; MR, Magnetic resonance; ASD, Adjacent segment degeneration; CSF, Cerebro-Spinal Fluid.

Address correspondence to: Jianhuang Wu, Department of Spinal, Xiangya Hospital, Central South University, No. 87 Xiangya Road, Changsha 410008, Hunan, China. E-mail: 93448157@qq.com

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