ORIGINAL ARTICLE

Can decompression surgery relieve low back pain in patients with lumbar spinal stenosis combined with degenerative lumbar scoliosis?

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Abstract

Introduction Decompression with fusion is usually recommended in patients with lumbar spinal stenosis (LSS) combined with degenerative lumbar scoliosis (DLS). However, elderly patients with LSS and DLS often have other comorbidities, and surgical treatment must be both safe and effective. The aim of this study was to investigate whether decompression surgery alone alleviates low back pain (LBP) in patients with LSS and DLS, and to identify the predictors of postoperative residual LBP.

Materials and methods A total of 75 patients (33 males and 42 females) with a mean age of 71.8 years (range 53–86 years) who underwent decompression surgery for LSS with DLS (Cobb angle ≥ 10°) and had a minimum follow-up period of 1 year, were retrospectively reviewed using the Japanese Orthopaedic Association scoring system for the assessment of lumbar spinal diseases (JOA score). Radiographic measurements included coronal and sagittal Cobb angles, apical vertebral rotation (Nash-Moe method), and anteroposterior and lateral spondylolisthesis. Logistic regression analysis was performed to investigate the predictors of residual LBP after surgery.

Results Forty-nine patients had preoperative LBP, of which 29 (59.1 %) experienced postoperative relief of LBP. Logistic regression analysis demonstrated that the degree of apical vertebral rotation on preoperative radiography was significantly associated with postoperative residual LBP (odds ratio, 8.16, 95 % confidence interval, 1.55–83.81, $p = 0.011$).

Conclusion A higher degree of apical vertebral rotation may therefore be an indicator of mechanical LBP in patients with LSS and DLS. Decompression with fusion should be recommended in these patients.

Keywords Lumbar spinal stenosis · Degenerative lumbar scoliosis · Decompression surgery · Low back pain

Introduction

Lumbar spinal stenosis (LSS) is a common problem in the older adult population, and is recognized as a cause of low back pain (LBP) and leg pain. Clinical outcome studies favor surgical over conservative treatment of LSS [2, 3, 19]. LSS is often accompanied by degenerative scoliosis, which complicates neural compression and makes surgical treatment more difficult [5, 33]. There is ongoing controversy regarding the most appropriate surgical treatment for LSS combined with degenerative lumbar scoliosis (DLS): decompression alone or decompression with spinal fusion [1, 4, 8, 9, 15, 16, 35]. It is important that surgical treatment is safe and effective, as patients in this age group often have other comorbidities including osteoporosis. Decompression alone has been demonstrated to be significantly less invasive than decompression combined with spinal fusion [36]. The purpose of this study was to investigate the feasibility of decompression surgery alone for LSS with DLS, focusing on the relief of LBP postoperatively. The predictors of postoperative residual LBP were also identified.

Materials and methods

Seventy-eight patients with no previous history of lumbar spine surgery underwent microendoscopic decompression

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surgery for LSS with DLS at our institution during 2009 and 2010. The diagnosis of LSS was made by clinical symptoms such as LBP, leg pain, numbness, and intermittent claudication, and was confirmed by magnetic resonance imaging. DLS was defined as coronal curvature (major lumbar curve) of $\geq 10°$ measured by the Cobb method [6] with the apex between L2 and L4. Surgery was performed for spinal stenosis located at the major lumbar curve and/or the compensatory lumbosacral curve below the major lumbar curve. Spinal stability was assessed on dynamic anteroposterior and lateral radiographs in the erect and supine positions, and patients with severe segmental instability were excluded. The decision whether to perform decompression surgery alone was based on our clinical experience after taking each patient's age, general health status, activity level, and willingness to undergo additional fusion into consideration [23]. Decompression was achieved through partial facetectomy, flavectomy, laminotomy, and foraminotomy.

All patients gave informed consent for inclusion in the study. The study design was approved by the Ethical Committee of Wakayama Medical University. Only patients with a follow-up period of at least 1 year were included. The Japanese Orthopaedic Association scoring system for the evaluation of LBP syndrome (JOA score) was used to assess the amount of LBP: none = 3, occasional mild pain = 2, occasional severe pain = 1, continuous severe pain = 0 [18]. Patients with a score of 1 or 0 were defined as suffering LBP. Radiographic measurements included lumbar lordosis (Cobb method), apical vertebral rotation (Nash-Moe method) [29], anteroposterior and lateral spondylolisthesis of each vertebra, and scoliosis.

To investigate the predictors of postoperative residual LBP, the amount of preoperative LBP (JOA score), the number of levels decompressed, and the preoperative radiographic parameters were compared between the patients with postoperative residual LBP (Group I) and those without postoperative residual LBP (Group II) at 1 year after surgery using the Student's t test or Chi square test, as appropriate. Logistic regression analysis was performed to determine the risk factors for residual LBP at 1 year after surgery, after adjustment for age and gender. Statistical analyses were performed using JMP (version 8, SAS Institute Inc., Cary, NC). Descriptive data are presented as the mean ± standard deviation. The level of statistical significance was set at 0.05.

Results

Seventy-five patients were eligible for inclusion in this analysis, comprising 33 men and 42 women with a mean age of 71.8 years (range 53–86 years). The mean preoperative scoliosis was 15.2° (range 10–37°). Decompression was performed at a single level in 34 patients, two levels in 36 patients, and three or more levels in 5 patients. Scoliosis did not progress significantly during the first year after surgery (mean, 15.7°, range 10–37°), and postoperative scoliosis was independent of the number of levels decompressed (single level 15.6 ± 6.2 vs multiple levels 15.9 ± 6.4, $p = 0.3134$). The overall total JOA score and LBP score were significantly improved at 1 year after surgery (19.1 ± 4.9 and 1.9 ± 0.8, respectively) compared with preoperative scores (13.4 ± 4.3 and 1.4 ± 0.7, respectively) (paired-t test, $p < 0.0001$).

Forty-nine of the 75 patients (65.3 %) experienced preoperative LBP (JOA score = 0 or 1). In 29 of these 49 patients (59.1 %), the pain was relieved at 1 year after surgery (JOA score = 2 or 3) (Group II). The remaining 20 patients had ongoing postoperative LBP (JOA score = 0 or 1) (Group I). Only 3 of the 26 patients without preoperative LBP (JOA score = 2 or 3) experienced postoperative LBP (JOA score = 0 or 1). Five perioperative complications were recorded in four patients: two dural tears (one in Group I and one in Group II) and three epidural hematomas (one in Group I and two in Group II). All dural tears were repaired intraoperatively, and no revision surgery was needed. All postoperative epidural hematomas were evacuated immediately, and no neurological deterioration was observed. The preoperative JOA score for LBP and the number of levels decompressed were not significantly different between Groups I and II (Table 1). Comparison of preoperative radiographic parameters between the groups showed that patients in group I had significantly greater scoliosis (13.7 ± 1.0° vs 18.8 ± 1.2°, $p = 0.0015$), lateral spondylolisthesis of L4 (0.9 ± 0.5 mm vs 2.5 ± 0.5 mm, $p = 0.0497$), and apical vertebral rotation (0.9 ± 0.4 vs 1.5 ± 0.6, $p = 0.0002$) than patients in group II (Table 1). Logistic regression analysis demonstrated that the degree of apical vertebral rotation on preoperative radiography was significantly related to postoperative residual LBP (odds ratio, 8.16, 95 % confidence interval, 1.55–83.81, $p = 0.011$) (Table 2).

Discussion

LSS is a major cause of LBP and leg pain in the elderly, and has become the most common indication for spinal surgery. Although good clinical outcomes have been described for decompression surgery without arthrodesis for LSS [1, 13, 16], it has been reported that the improvement in LBP is poorer than the improvement in leg pain and walking ability after surgery [17].

LSS is most commonly caused by degenerative changes in the aging spine, which may already have an element of

Table 1 Comparison of preoperative LBP, number of decompression levels, scoliosis, lordosis, spondylolisthesis, and apical vertebral rotation between patients with postoperative residual LBP (Group I) and whose without postoperative residual LBP (Group II) at 1 year after surgery

	Group I	Group II	p value
Preoperative JOA score of LBP	0.9 ± 0.0	1.0 ± 0.1	0.7908*
No. of decompression levels	1.6 ± 0.1	1.7 ± 0.1	0.3206*
Cobb (°)			
Coronal	18.8 ± 1.2	13.7 ± 1.0	**0.0015***
Sagittal	26.2 ± 2.8	31.4 ± 2.4	0.1642*
Anteroposterior spondylolisthesis (mm)			
L1	0.0 ± 0.3	0.5 ± 0.3	0.2067*
L2	0.5 ± 0.4	1.0 ± 0.3	0.2801*
L3	0.5 ± 0.4	0.9 ± 0.3	0.374*
L4	2.2 ± 0.7	3.0 ± 0.6	0.4189*
L5	0.5 ± 0.3	0.2 ± 0.2	0.4931*
Lateral spondylolisthesis (mm)			
L1	0.4 ± 0.2	0.1 ± 0.2	0.3464*
L2	0.6 ± 0.5	0.7 ± 0.4	0.8186*
L3	3.8 ± 0.9	3.2 ± 0.8	0.653*
L4	2.5 ± 0.6	0.9 ± 0.5	**0.0497***
L5	0.0 ± 0.3	0.3 ± 0.2	0.4931*
Apical vertebral rotation (Nash-Moe)	1.5 ± 0.6	0.9 ± 0.4	**0.0002†**

Values are the mean ± standard deviation. Bold values are statistically significant

LBP low back pain, *No* number, *JOA score* Japanese Orthopaedic Association score for the evaluation of low back pain syndrome

* Student's *t* test

† Chi squared test

Table 2 Logistic regression analysis to identify factors associated with postoperative residual low back pain

Variables	Odds ratio	95 % Confidence intervals	p value
Sex (male vs female)	2.83	0.50–12.91	0.2761
Age (+1SD)	2.4	0.13–70.0	0.5013
Lateral spondylolisthesis of L4 (+1SD)	3.54	0.34–41.14	0.4644
Scoliosis (+1SD)	3.47	0.11–111.26	0.287
Apical vertebral rotation (+1 grade)	8.16	1.55–73.81	**0.0112**

Bold values are statistically significant

congenital or developmental stenosis [5]. Aging affects bony structures, intervertebral discs, ligaments, facet joints, and muscles [33]. Collapse and bulging of the disc, facet joint arthrosis, and ligamentum flavum hypertrophy cause spinal stenosis and neural compression. Asymmetrical disc degeneration results in DLS and reduced lumbar lordosis [24, 28]. Aging may also induce degenerative myopathy, leading to rotatory scoliosis and kyphosis [33]. All of these degenerative changes may contribute to LBP, although sciatica only occurs when there is direct pressure or stretching of an inflamed, stretched, or compressed nerve root [25, 27, 28, 33, 34, 38]. The impact of decompression surgery for LSS with DLS on LBP is therefore uncertain.

In this study, most DLS was considered to be de novo scoliosis, because of the magnitude of curvature [24, 28]. Ploumis et al. [32] investigated neural canal dimensions in patients with de novo degenerative scoliosis. They concluded that ligamentum flavum hypertrophy, posterior disc bulging, and bony overgrowth were more likely to contribute to reduced neural canal dimensions than scoliosis, as these are similar to the changes in degenerative LSS without scoliosis. Decompression without arthrodesis is therefore thought to be an appropriate treatment option to consider for LSS with DLS. Hansraj et al. [15] classified LSS into two categories: typical LSS and complex LSS. Decompression without arthrodesis was recommended for typical LSS with no history of previous lumbar spine operation, no spinal instability, and DLS ≤ 20°. Our surgical strategy for LSS is similar to their treatment algorithm. Grob et al. [14] reported that arthrodesis is not necessary after decompression in the absence of segmental instability in patients with degenerative LSS. The JOA score has been extensively used for clinical research in Japan, and its reliability and validity have been demonstrated [12]. According to this scoring system, decompression significantly alleviated the preoperative symptoms including LBP at 1 year after surgery in the overall patient population analyzed in this study. Pao et al. [31] reported the short-term clinical outcomes of microendoscopic decompression laminotomy for degenerative LSS using the JOA score. The total JOA score in their study improved from 9.4 ± 6.1 to 24.2 ± 6.0 at the final follow-up (range 12–24 months), which was a better improvement than in our study. Although LBP is not significantly more common than leg pain, numbness, and claudication in patients with LSS [26, 33], preoperative DLS is reported to be associated with less improvement in LBP after decompression surgery for LSS [10]. In the study by Pao et al. LSS was not associated with DLS. The less favorable outcomes in our study may be due to residual LBP caused by DLS.

In this study, about 60 % of patients experienced relief of LBP after decompression of neural components including the spinal nerve roots. Decompression surgery may reduce radicular LBP, which is usually accompanied by pain radiating to the leg via the nerve root [11]. However, mechanical (non-radicular) LBP cannot be resolved by decompression alone. A significant portion of postoperative residual LBP might be of mechanical origin, which

is often referred to spinal instability. Recently, decompression with fusion was demonstrated to be associated with better results than decompression alone in patients with segmental instability in the degenerative lumbar spine [23]. However, lumbar fusion was also found to correlate with clinical improvement in patients with axial LBP due to lumbar disc degeneration in the absence of clear instability [7]. There is no consensus regarding the definition of spinal instability as a cause of LBP. An abnormal increase in movement of the functional spinal units is commonly seen in asymptomatic individuals. Furthermore, excessive axial load to the spinal units due to disc degeneration may cause LBP [7, 39]. Therefore, use of the term "clinical spinal instability" is preferred over the term "mechanical instability" [22, 30]. In this study, the assessment of spinal stability and the choice of surgical treatment in each case was based on our clinical experience, which may have led to bias, as previously described [23].

Logistic regression analysis found that a higher degree of apical vertebral rotation on preoperative radiography was a good predictor of residual LBP after surgical decompression for LSS with DLS. Preoperative LBP and the number of levels surgically treated were not associated with postoperative LBP. Patients with DLS often have rotatory spondylolisthesis, most frequently at the L3–4 level, which is usually the apex of the DLS [33]. The severity of apical vertebral rotation corresponds to the severity of the scoliosis, because the rotation increases with an increasing magnitude of curvature [33]. Kostuik et al. and Velis and Thorne described lateral spondylolisthesis as an important factor in the development of back pain. Schwab et al. demonstrated that pain correlates with L3 and/or L4 obliquity and lateral rotatory spondylolisthesis [25, 38]. A high degree of apical vertebral rotation may therefore be an indicator of mechanical LBP due to clinical instability. In such cases, decompression and fusion should be recommended. The results of the present study may be helpful in the discussion of surgical treatment options between surgeons and patients with LSS and DLS.

This study only had a short follow-up period of 12 months. Previous literature [20, 21, 37] has indicated that surgical outcomes for LSS deteriorate over the long term, including the development of severe LBP. Recently, microendoscopic decompression surgery has been used for the treatment of LSS because of its minimally invasive nature. Decompression can be accomplished through a small skin incision with preservation of the posterior stabilizing structures [31]. Therefore, long-term outcomes may be different from those previously reported for conventional decompression surgery. To our knowledge, there are no previous reports focusing on LBP after decompression surgery for LSS with DLS. Further investigation is

necessary to assess the feasibility of decompression surgery without fusion for LSS with DLS.

Conclusion

There is ongoing controversy regarding the best treatment option for elderly patients with LSS and DLS: decompression only versus decompression with spinal fusion. To investigate the feasibility of decompression surgery only, clinical outcomes were retrospectively reviewed using JOA scores, focusing on LBP after surgery. Approximately 60 % of patients with LSS and DLS experienced relief of LBP after decompression surgery. Relief of LBP was significantly associated with the degree of apical vertebral rotation on preoperative radiography. Further follow-up studies are necessary to corroborate these findings.

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