The Spine Journal 19 (2019) 995–1000

Clinical Study

Retrolisthesis and lumbar disc herniation: a postoperative assessment of outcomes at 8-year follow-up

Kartik Shenoy, MD[a,*], Nicholas Stekas, BS[a], Chester J. DonnallyIII, MD[b], Wenyan Zhao, PhD[c], Yong H. Kim, MD[a], Jon D. Lurie, MD, MS[d], Afshin E. Razi, MD[e]

[a] *Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, NY 10003, USA*
[b] *Department of Orthopedics, University of Miami Hospital, Miami, FL 33136, USA*
[c] *Department of Orthopaedics, Dartmouth Medical School, Hanover, NH 03755, USA*
[d] *Department of Medicine and of Community and Family Medicine and of TDI, Dartmouth Medical School, Hanover, NH 03755, USA*
[e] *Department of Orthopaedic Surgery, Maimonides Bone and Joint Center, Maimonides Medical Center, Brooklyn, NY 11201, USA*

Received 29 August 2018; revised 18 December 2018; accepted 18 December 2018

Abstract

BACKGROUND CONTEXT: Lumbar disc herniation and retrolisthesis have been shown to be significant degenerative changes that can be associated with back pain. Current literature has shown evidence that retrolisthesis is associated with similar baseline function in patients with L5–S1 disc herniation, but worse postoperative outcomes 2 years after lumbar discectomy. However, literature comparing long-term postoperative outcomes at 8-year follow-up in patients with L5–S1 disc herniation with retrolisthesis is lacking.

PURPOSE: The purpose of the present study is to compare long-term postoperative outcomes at 8-year follow-up in patients with retrolisthesis and L5–S1 disc herniations to patients with L5–S1 disc herniations without retrolisthesis.

STUDY DESIGN: Retrospective review of prospectively collected data from the Spine Patients Outcomes Research Trial (SPORT) database.

PATIENT SAMPLE: Sixty-five patients who underwent lumbar discectomy for L5–S1 disc herniations with 8-year follow-up from the SPORT.

OUTCOME MEASURES: Short Form (SF)-36 bodily pain scale, SF-36 physical function scale, Oswestry Disability Index, Sciatica Bothersomeness Index, and reoperation rate.

METHODS: Baseline surgical parameters, length of stay, complication rates, reoperation rates, and outcome measures were recorded in the SPORT database. Follow-up data were collected at 6 weeks, 3 months, 6 months, 1 year, 2 years, 3 years, 4 years, 5 years, 6 years, 7 years, and 8 years. Retrolisthesis was defined as posterior subluxation ≥8%. Patients with and without retrolisthesis were compared using a mixed-effects model of longitudinal regression. Outcomes were calculated as time-weighted averages over 8 years. Reoperation rates were compared using the log-rank test based on time to first reoperation.

RESULTS: One hundred-twenty five patients met inclusion criteria for the present study, including 29 patients with retrolisthesis (23.3%) and 96 patients who did not have retrolisthesis (76.7%). The greatest difference in clinical outcome measures was found at 2 years postoperatively. This was the only point at which both the Short Form-36 Bodily Pain scale (SF-36 BP) and PF showed significant differences between the retrolisthesis and nonretrolisthesis group. At 3 years, SF-36 BP was significantly lower in patients with retrolisthesis (39.9 vs. 52, p=.046).

FDA device/drug status: Not applicable.

Author disclosures: ***KS:*** Nothing to disclose. ***NS:*** Nothing to disclose. ***CJD:*** Nothing to disclose. ***WZ:*** Nothing to disclose. ***YHK:*** Consulting: Biomet (B), Hans Biomed (B). ***JDL:*** Stock Ownership: Spinol (<1%); Consulting: Foundation for Informed Medical Decision Making (None), FzioMed (None), NewVert (Stock Ownership disclosed); Board of Directors: National Institute for Sports Science and Safety (Nonfinancial). ***AER:*** Nothing to disclose.

* Corresponding author. Department of Orthopedic Surgery, NYU Orthopedic Hospital, NYU Langone Medical Center, 301 E 17th Street, 14th Floor, New York, NY 10003, USA. Tel.: (212)-598-6000.

E-mail address: kartik.shenoy@nyulangone.org (K. Shenoy).

https://doi.org/10.1016/j.spinee.2018.12.010

At 8-year follow-up, the presence of retrolisthesis in patients undergoing L5−S1 discectomy was not associated with worse outcome measure scores based on the area under the curve analysis for any metric investigated (SF-36 BP 41.4 vs. 47.1, p=.18; SF-36 Physical Function scale 38.9 vs. 45.4, p=.12; Oswestry Disability Index −39.4 vs. −34.8, p=.23; −11.6 vs. −10.4, p=.25) or a difference in reoperation rate (retrolisthesis group 10%, nonretrolisthesis group 17%, p=.41).

CONCLUSIONS: While retrolisthesis can contribute to low back pain and dysfunction in patients undergoing lumbar discectomy for L5−S1 herniated nucleus pulposus in early follow-up, no significant difference was found in postoperative outcomes after 3 years. Additionally, retrolisthesis was not found to be associated with different reoperation rates at 8 years postoperatively.

Keywords: Low back pain; Herniated nucleus pulposus; Retrolisthesis; Lumbar discectomy; Degenerative lumbar disease; Lumbar disc herniation

Introduction

Back pain will affect up to 84% of adults at some point in their lives and is a major contributor to more disability worldwide than any other condition [1,2]. While the source of back pain can be difficult to isolate, pathology such as disc degeneration, herniation, degeneration of the posterior elements, and instability can all be contributors [3]. Instability in the form of retrolisthesis, defined as posterior translation of one vertebral body with respect to the subjacent vertebral body, has been shown to be a significant contributor to disc degeneration and back pain [4,5]. Therefore, it has been theorized that the combination of retrolisthesis and disc pathology can cause increased low back pain.

Although there have been reports on the factors associated with improved outcomes following discectomy [6,7], there is a lack of literature regarding the relationship between retrolisthesis and disc herniation. Furthermore, to our knowledge there are no studies looking at long-term outcomes following discectomy in patients with retrolisthesis. In the prior study examining preoperative patient function before discectomy, there was no significant relationship between retrolisthesis in patients with L5−S1 disc herniation and worse baseline pain or function [8]. Postoperatively at 4 years, patients with retrolisthesis did significantly worse with regards to bodily pain and physical function but had no significant differences in Oswestry Disability Index (ODI) and Sciatica Bothersome Index (SBI) scores. It was thought that preoperatively, any pain contributed by the retrolisthesis was masked by the disc herniation, however postoperatively, after the pain of the herniation subsided, the pain effects of the retrolisthesis became more evident in the midterm 2−4 years postoperative period [9].

The purpose of this study is to expand on the prior studies analyzing the long-term impact of retrolisthesis on patients who underwent L5−S1 discectomy for herniated nucleus pulposus. This study aims to determine if the midterm effects of retrolisthesis on postoperative outcomes persist and to analyze the relationship between preoperative retrolisthesis on reherniation, reoperation rates as well as health related outcome measures at 8 years postoperatively.

Materials and methods

Study population

Individuals for this study were drawn from those enrolled in the Spine Patient Outcomes Research Trial randomized study, a multicenter database of spine patients from 13 institutions across the United States. From these we identified individuals with complete sets of MRI scans confirming a L5−S1 level disc herniation and subsequently underwent L5−S1 discectomy. Individuals with anterolisthesis were excluded leaving 125 individuals between 2001 and 2004 included in this study.

MRI scans

Magnetic resonance images of the lumbar spine were viewed and evaluated on a digital monitor using specialized software (eFilm software, Merge EMed, Inc., Milwaukee, WI, USA). Clinical scans were collected so there was no predefined magnet strength or acquisition protocol. All images were done supine. As described by Shen et al., the amount of L5−S1 listhesis was determined by measuring the position of the L5 vertebral body relative to S1 on midsagittal T1-weighted MRI images [8].

Vertebral measurements and analysis

L5−S1 lumbar listhesis was defined as posterior subluxation of 3 mm or more which corresponded to a slip of 8%, or the lower limit of defining retrolisthesis. This method by which retrolisthesis and degenerative changes of the disc, end plate, and posterior elements were evaluated has been previously reported [8,9].

Spine patient outcomes research trial outcome measures

Baseline surgical parameters, length of stay and complication rates were collected and previously reported [9]. Additionally, follow-up data from 6 weeks, 3 months, 6

months, 1 year, 2 years, 3 years, 4 years, 5 years, 6 years, 7 years, and 8 years on reoperation rate and health related outcome measures were gathered. These measures included the Short Form-36 Bodily Pain scale (SF-36 BP), SF-36 Physical Function scale, ODI, and SBI.

Data analysis

Comparison of outcomes between patients with and without retrolisthesis were performed by evaluating the change from baseline using a mixed-effects model of longitudinal regression including a random individual effect to account for the correlation between repeated measurements from the same patient. Outcomes were calculated as the time-weighted average (area under the curve—AUC) over 8 years. Adjustments were made for age, gender, compensation status, and baseline scores. Computations were done using SAS procedures PROC MIXED for continuous data and PROC GENMOD for binary and non-normal secondary outcomes (SAS version 9.4, SAS Institute Inc., Cary, NC, USA). Statistical significance was defined as $p<.05$ based on a two-sided hypothesis test with no adjustments made for multiple comparisons. Reoperation data were compared among patients with and without retrolisthesis using the log-rank test based on time to first reoperation.

Results

Of the patients with 8-year outcomes, in this analysis 12 patients were identified to have retrolisthesis (18.5%) and the remaining 53 did not have retrolisthesis. MRI analysis showed the incidence of posterior degeneration, intervertebral disc T2 signal loss and Modic changes to be 35.25%, 73.6%, and 28.6%, respectively.

Relation of retrolisthesis and degenerative changes to health-related outcome measures

Health related outcome measures were recorded at yearly follow-up and compared to assess for variability over time based on the presence of retrolisthesis. Previously it was seen that the trend over 4 years was toward a difference in bodily pain and physical function without any difference between ODI and SBI. The greatest difference as measured by AUC analysis was found to be at 2-year follow-up. This was the only point at which both the SF-36 BP and PF showed significant differences between the retrolisthesis and nonretrolisthesis group. At 3 years, SF-36 BP was significantly worse in patients with retrolisthesis (39.9 vs. 52, p=.046). There was no significant difference in outcome measures at any other time point thereafter measured yearly until 8 years postoperatively (Appendix 1).

At the 8-year follow-up, it was found that the presence of retrolisthesis in patients undergoing L5–S1 discectomy was not associated with worse outcome measure scores based on the AUC analysis for any metric investigated (SF-36 BP 41.4 vs. 47.1, p=.18; SF-36 Physical Function scale 38.9 vs. 45.4, p=.12; ODI −39.4 vs. −34.8, p=.23; −11.6 vs. −10.4, p=.25). Similarly, the presence of degenerative changes on MRI, as measured by posterior degeneration, T2 signal loss, and Modic changes, was also not associated with worse outcome measure scores at 8-year follow-up (Table 1, Fig. 1).

Relation of retrolisthesis and to reoperation

There was no statistically significant difference between the retrolisthesis and nonretrolisthesis groups in terms of the incidence of reoperation at any time point, including at 8-year follow-up (reoperation rate: 10% vs. 17%, p=.41; Table 2). Recurrent disc herniation, complication and a new surgical condition were the most common reasons for reoperation. There were no significant differences between the retrolisthesis and nonretrolisthesis groups for all reasons for reoperation.

Discussion

Historically, retrolisthesis was considered an incidental finding of no clinical significance, however, today we know that retrolisthesis can result in disc space narrowing and consequently radiculopathy through cephalad movement of the superior articular facet into the neuroforamen [10,11]. As a result, the relationship between retrolisthesis and back pain is now more clearly delineated.

In the prior study, there was no association between retrolisthesis and preoperative back pain and function in patients undergoing discectomy for herniated nucleus pulposus. However, this was thought to be the result of the pain of the herniation masking pain from retrolisthesis. Other studies have shown a relationship between retrolisthesis and back pain [4,5]. The postoperative 4-year data from our second study demonstrated a significant difference in pain and function scores in patients with and without retrolisthesis thereby supporting the studies by Vogt et al.

Discogenic back pain following discectomy may be a contributor to the difference in pain and function scores seen at the 2- and 3-year follow-up in the prior study. Lotz and Ulrich suggested that increased innervation, inflammation and hypermobility are what contribute to painful discs [12]. It is generally believed that only the annulus fibrosis is innervated, however, in the pathologic disc, nerve endings can grow into the disc leading to increased pain [13]. Both the retrolisthesis and nonretrolisthesis groups would have these first two components suggested by Lotz and Ulrich but the retrolisthesis group has the added component of hypermobility. This added component may explain the significant difference in pain and function scores seen at 2 and 3 years postoperatively. Longer-term follow-up showed no difference in all health related outcome measures each year after postoperative year 3 until the most recent follow-up 8 years postoperatively. Although patients with retrolisthesis consistently had worse scores

Table 1
SPORT IDH 8-year retrolisthesis—adjusted* weighted average 8 years change scores and group differences (AUC)

	Mean (SE) at baseline			AUC of mean change from baseline (SE)			
	No retrolisthesis (n=96)	Retrolisthesis (n=29)	Overall mean	No retrolisthesis	Retrolisthesis	Group difference (95% CI)	p value
BP	21.8 (1.7)	26.4 (3.6)	23.2	47.1 (2)	41.4 (3.8)	5.7 (−2.7, 14.1)	.18
PF	29.3 (2.5)	35.4 (3.6)	30.3	45.4 (1.9)	38.9 (3.7)	6.5 (−1.6, 14.6)	.12
ODI	57.4 (2)	51.8 (3.6)	56	−39.4 (1.7)	−34.8 (3.3)	−4.5 (−11.9, 2.9)	.23
SBI	16.9 (0.48)	15.7 (1)	16.7	−11.6 (0.7)	−10.4 (0.8)	−1.2 (−3.3, 0.9)	.25
	No posterior degeneration (n=51)	Posterior degeneration (n=29)	Overall mean	No posterior degeneration	Posterior degeneration	Group difference (95% CI)	p value
BP	23.3 (2.6)	20.9 (2.7)	23.2	42.6 (2.8)	45.3 (3.6)	−2.8 (−11.7, 6.1)	.54
PF	29 (3.2)	28.6 (3.8)	28.6	44.5 (2.8)	45.4 (3.6)	−0.8 (−9.7, 8.1)	.86
ODI	57.3 (2.8)	58.3 (3.2)	56.8	−36.7 (2.5)	−40.6 (3.3)	3.9 (−4.2, 12)	.35
SBI	15.8 (0.72)	18 (0.71)	16.8	−10.9 (1.1)	−10.9 (0.8)	0 (−2.4, 2.4)	.98
	No T2 signal loss (n=28)	T2 signal loss (n=78)	Overall mean	No T2 signal loss	T2 signal loss	Group difference (95% CI)	p value
BP	20.3 (3.1)	23.5 (2.1)	23.2	47.9 (3.7)	46.2 (2.1)	1.8 (−6.6, 10.2)	.68
PF	37.9 (4.7)	28.1 (2.5)	30.6	44.2 (3.7)	44.4 (2.2)	−0.3 (−8.8, 8.2)	.95
ODI	52.3 (3.6)	58.3 (2.2)	56.2	−39.8 (3.2)	−39.3 (1.9)	−0.5 (−7.8, 6.8)	.89
SBI	16.2 (0.77)	16.8 (0.6)	16.6	−17.4 (4.6)	−11.3 (0.6)	−6.2 (−15.1, 2.7)	.18
	No modic changes (n=55)	Modic changes (n=22)	Overall mean	No modic changes	Modic changes	Group difference (95% CI)	p value
BP	22.9 (2.7)	21.1 (3.7)	22.7	48.3 (2.5)	42.7 (4.1)	5.6 (−4, 15.2)	0.25
PF	31.2 (3.4)	23.2 (4.5)	28.4	48.3 (2.5)	41.4 (4)	6.9 (−2.4, 16.2)	0.15
ODI	57.1 (2.9)	60.3 (4.5)	58.1	−42.8 (2.2)	−36.7 (3.5)	−6.2 (−14.5, 2.1)	0.15
SBI	16.3 (0.73)	18.6 (0.8)	16.8	−16 (4.5)	−10.3 (0.9)	−5.6 (−14.6, 3.4)	0.22

SPORT, Spine Patient Outcomes Research Trial; IDH, intervertebral disc herniation; AUC, area under the curve; SE, standard error; CI, confidence interval; SF, short form; BP, SF-36 bodily pain; PF, SF-36 physical function; ODI, Oswestry Disability Index; SBI, Sciatica Bothersomeness Index.

* Adjusted for age, gender, compensation, and baseline score.

during the follow-up period, there was no statistical difference. At 8 years, the lack of significant difference is likely due to continued micromotion and hypermobility leading to increased spondylotic changes that ultimately halt any more motion resulting in decreased pain. These new data allow surgeons to guide postoperative expectations in patients undergoing L5−S1 discectomy in the presence of retrolisthesis.

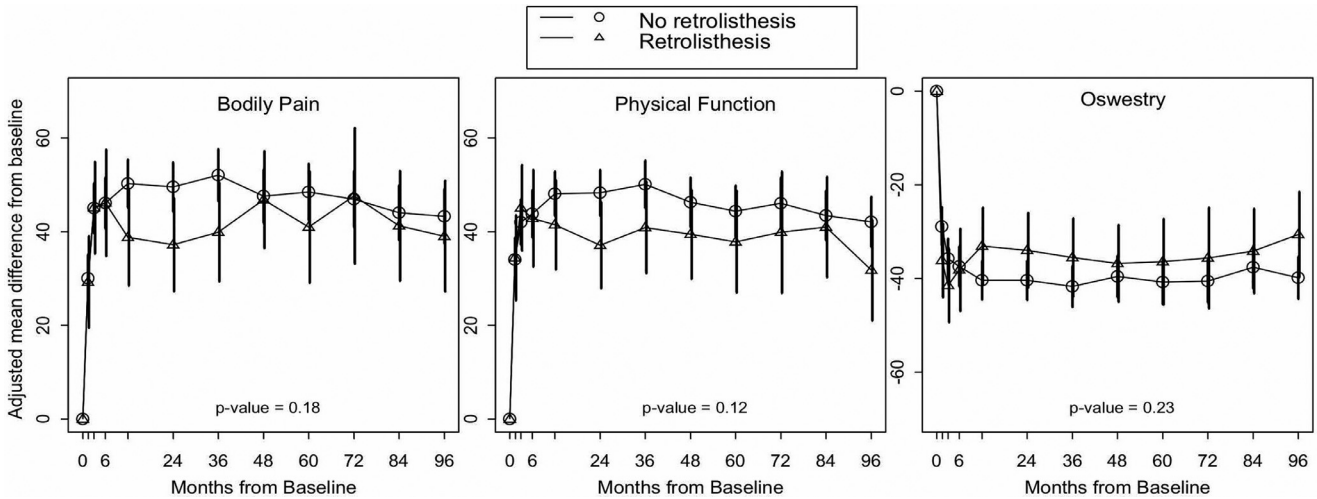

Fig. Primary outcomes over time by retrolisthesis with area under curve p value that compares retrolisthesis group to nonretrolisthesis group.

Table 2
Retrolisthesis cohort: operative information, complications, and repeat surgery rates

	Retrolisthesis		
	No (n=96)	Yes (n=29)	p value
Discectomy Level—no. (%)			
L2–L3/L3–L4	0 (0%)	0 (0%)	–
L4–L5	1 (1%)	1 (3%)	.95
L5–S1	96 (100%)	29 (100%)	–
Operation time, minutes (SD)	71.6 (32.4)	73.3 (23)	.80
Blood loss, cc (SD)	63.7 (154.7)	52 (27.3)	.69
Had blood replacement	1 (1%)	0 (0%)	.52
Length of stay			.32
Same day	31 (32%)	10 (34%)	
One night	52 (54%)	18 (62%)	
Two+nights	13 (14%)	1 (3%)	
Intraoperative complications*			
Dural tear/spinal fluid leak	1 (1%)	1 (3%)	.95
None	95 (99%)	28 (97%)	.95
Postoperative complications/events†			
Wound infection—superficial	2 (2%)	1 (3%)	.79
Wound infection—deep	2 (2%)	0 (0%)	.95
Other	1 (1%)	2 (7%)	.27
None	91 (95%)	26 (90%)	.58
Additional spine surgeries (1-year rate)‡	8 (8%)	1 (3%)	.39
Additional spine surgeries (2-year rate)‡	10 (10%)	2 (7%)	.58
Additional spine surgeries (3-year rate)‡	11 (11%)	2 (7%)	.49
Additional spine surgeries (4-year rate)‡	12 (12%)	2 (7%)	.42
Additional spine surgeries (5-year rate)‡	12 (12%)	2 (7%)	.42
Additional spine surgeries (6-year rate)‡	14 (15%)	2 (7%)	.29
Additional spine surgeries (7-year rate)‡	16 (17%)	2 (7%)	.21
Additional spine surgeries (8-year rate)‡	16 (17%)	3 (10%)	.41
Recurrent disc herniation	7 (7%)	3 (10%)	
Complication or other	3 (3%)	1 (NE)§	
New condition	4 (4%)	0 (NE)§	

SD, standard deviation; CSF, cerebrospinal fluid.

* Intraoperative complications not reported: aspiration, nerve root injury, operation at wrong level, vascular injury, and ''other.''

† Postoperative complications/events not reported: blood transfusion, bone graft complication, CSF leak, nerve root injury, paralysis, cauda equina injury, pseudoarthrosis, wound dehiscence, and wound hematoma.

‡ Postsurgical reoperation rates are Kaplan-Meier estimates based on time to first reoperation.

§ Not estimable.

This study is not without limitations. Given the cross-sectional study design, only associations can be drawn from the data. Additionally, the patient sample is small and as result may be inadequately powered to study many associations including one between reherniation and retrolisthesis as mentioned above. Furthermore, this study only looked at L5–S1 discectomy patients and therefore, further research into nonoperative treatment and other surgical procedures is needed to truly determine the contribution of retrolisthesis to low back pain and function. One other limitation to this study is lack of data regarding long term radiographic follow-up for the nonretrolisthesis cohort. It is theoretically possible that some of these patients went on to develop retrolisthesis, which may confound the results presented in this study.

The study found that patients with retrolisthesis have worse short term, but similar long-term outcomes when compared with patients without retrolisthesis. With this information, spine surgeons can preoperatively tailor patient expectations with regard to outcomes and time to recovery. Specifically, they can educate those with retrolisthesis that they may take longer to recover with regards to back pain and function. Additionally, surgeons can understand that their patients with retrolisthesis may experience a slower recovery compared to other patients.

Conclusions

The results of this study show that patients with preoperative retrolisthesis at L5–S1 experienced increased low back pain and unfavorable health-related outcome measures during the early postoperative period. These differences were observed up to 2 years postoperatively. However, after 3 years these findings are no longer statistically significant. With this knowledge, surgeons can properly preoperatively counsel patients and tailor expectations in order to maintain patient satisfaction.

Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.spinee.2018.12.010.

References

[1] Cassidy JD, Carroll LJ, Cote P. The Saskatchewan health and back pain survey. The prevalence of low back pain and related disability in Saskatchewan adults. Spine 1998;23:1860–6. discussion 1867.
[2] Hoy D, March L, Brooks P, Blyth F, Woolf A, Bain C, et al. The global burden of low back pain: estimates from the global burden of disease 2010 study. Ann Rheum Dis 2014;73:968–74.
[3] Biyani A, Andersson GB. Low back pain: pathophysiology and management. J Am Acad Orthop Surg 2004;12:106–15.
[4] Vogt MT, Rubin D, Valentin RS, Palermo L, Donaldson 3rd WF, Nevitt M, et al. Lumbar olisthesis and lower back symptoms in elderly white women. The study of osteoporotic fractures. Spine 1998;23:2640–7.
[5] Vogt MT, Rubin DA, Palermo L, Christianson L, Kang JD, Nevitt MC, et al. Lumbar spine listhesis in older African American women. Spine J 2003;3:255–61.
[6] Epstein NE. Foraminal and far lateral lumbar disc herniations: surgical alternatives and outcome measures. Spinal Cord 2002;40:491–500.
[7] Haugen AJ, Grovle L, Brox JI, Natvig B, Keller A, Soldal D, Grotle M. Estimates of success in patients with sciatica due to

lumbar disc herniation depend upon outcome measure. Eur Spine J 2011;20:1669–75.
[8] Shen M, Razi A, Lurie JD, Hanscom B, Weinstein J. Retrolisthesis and lumbar disc herniation: a preoperative assessment of patient function. Spine J 2007;7:406–13.
[9] Kang KK, Shen MS, Zhao W, Lurie JD, Razi AE. Retrolisthesis and lumbar disc herniation: a postoperative assessment of patient function. Spine J 2013;13:367–72.
[10] O'Brien JP. The role of fusion for chronic low back pain. Orthop Clin North Am 1983;14:639–47.
[11] Sihvonen T, Lindgren KA, Airaksinen O, Manninen H. Movement disturbances of the lumbar spine and abnormal back muscle electromyographic findings in recurrent low back pain. Spine 1997;22: 289–95.
[12] Lotz JC, Ulrich JA. Innervation, inflammation, and hypermobility may characterize pathologic disc degeneration: review of animal model data. J Bone Joint Surg Am 2006;88(Suppl 2):76–82.
[13] Freemont AJ, Peacock TE, Goupille P, Hoyland JA, O'Brien J, Jayson MI. Nerve ingrowth into diseased intervertebral disc in chronic back pain. Lancet 1997;350:178–81.