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Retrolisthesis and lumbar disc herniation: a preoperative assessment of patient function

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Abstract

BACKGROUND CONTEXT: Retrolisthesis is relatively rare but when present has been associated with increased back pain and impaired back function. Neither the prevalence of this condition in individuals with lumbar disc herniations nor its possible relation to preoperative back pain and dysfunction has been well studied.

PURPOSE: The purposes of this study were as follows: (1) to determine the prevalence of retrolisthesis (alone or in combination with other degenerative conditions) in individuals with confirmed L5–S1 disc herniation who later underwent lumbar discectomy; (2) to determine if there is any association between retrolisthesis and degenerative changes within the same vertebral motion segment; and (3) to determine the relation between retrolisthesis (alone or in combination with other degenerative conditions) and preoperative low back pain, physical function, and quality of life.

STUDY DESIGN/SETTING: Cross-sectional study.

PATIENT SAMPLE: A total of 125 individuals were identified for incorporation into this study. All patients had confirmed L5–S1 disc herniation on magnetic resonance imaging (MRI) and later underwent L5–S1 discectomy. All patients were enrolled in the Spine Patient Outcomes Research Trial (SPORT) study; data were obtained from the multi-institutional database comprised of SPORT patients from across the United States.

OUTCOME MEASURES: Retrolisthesis, degenerative change on MRI, and Modic changes.

METHODS: MRI scans of the lumbar spine were assessed at spinal level L5–S1 for all 125 patients. Retrolisthesis was defined as posterior subluxation of 8% or more. Disc degeneration was defined as any loss of disc signal on T2 imaging. Modic changes were graded 1 to 3 and collectively classified as vertebral endplate degenerative changes. The presence of facet arthropathy and ligamentum flavum hypertrophy was classified jointly as posterior degenerative changes.

RESULTS: The overall incidence of retrolisthesis at L5–S1 in our study was 23.2%. Retrolisthesis combined with posterior degenerative changes, degenerative disc disease, or vertebral endplate changes had incidences of 4.8%, 16%, and 4.8% respectively. The prevalence of retrolisthesis did not vary by sex, age, race, smoking status, or education level when compared with individuals with normal sagittal alignment. However, individuals with retrolisthesis were more likely to be receiving workers' compensation than those without retrolisthesis. Increased age was found to be associated with individuals having vertebral endplate degenerative changes (both alone and in conjunction with retrolisthesis) and degenerative disc disease. Individuals who had retrolisthesis with concomitant vertebral endplate degenerative changes were more often smokers and had no insurance. The presence of retrolisthesis was not associated with an increased incidence of having degenerative disc disease, posterior degenerative changes, or vertebral endplate changes. No

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statistical significance was found between the presence of retrolisthesis on the degree of patient preoperative low back pain and physical function. Patients with degenerative disc disease were found to have increased leg pain compared with those patients without degenerative disc changes.
CONCLUSIONS: We found no significant relationship between retrolisthesis in patients with L5–S1 disc herniation and worse baseline pain or function. It is possible that the contribution of pain or dysfunction related to retrolisthesis was far overshadowed by the presence of symptoms caused by the concomitant disc herniation. It remains to be seen whether retrolisthesis will affect outcome after discectomy in these patients.

Keywords: Retrolisthesis; Preoperative; Lumbar discectomy; Lumbar disc herniation; Back pain; Physical function; Degenerative lumbar disease

Introduction

Retrolisthesis (backwards slippage of one vertebral body on another) has historically been regarded as an incidental finding, one that does not cause any symptoms and is considered to be of little or no clinical significance. Few studies have been done to date, and little is known about this condition. The literature has found a possible association between retrolisthesis and increased back pain and impaired back function [1–4].

Retrolisthesis may occur more commonly than initially believed. Series have shown that retrolisthesis may be present in up to 30% of extension radiographs of patients complaining of chronic low back pain [5]. Retrolisthesis has been found to be associated with disc degeneration, decrease in lumbar lordosis, and decrease in vertebral endplate angle [6–9].

Little is known about the effect of retrolisthesis in patients with operative conditions such as lumbar disc herniation. Do individuals with lumbar disc herniations have increased levels of back pain, back dysfunction, and decreased quality of life preoperatively if they have concomitant retrolisthesis at the involved herniated disc level? Does the presence of degenerative changes (disc degeneration, degenerative endplate changes, and posterior element degenerative changes) along with retrolisthesis worsen the symptoms and/or possibly the prognosis in these operative cases? The purposes of this study were as follows: (1) to determine the prevalence of retrolisthesis (alone or in combination with other degenerative conditions) in a cohort of individuals with confirmed L5–S1 disc herniations who later underwent lumbar discectomy; (2) to determine if there is any association between retrolisthesis and degenerative changes within the same vertebral motion segment; and (3) to determine the relation between retrolisthesis (alone or in combination with other degenerative conditions) and preoperative low back pain, physical function, and quality of life.

Materials and methods

Study population

Individuals for this study were drawn from those enrolled in the Spine Patient Outcomes Research Trial (SPORT) randomized study, a muliticenter database of spine patients from 13 institutions across the United States. All individuals in the current study population had complete sets of magnetic resonance imaging (MRI) scans confirming a L5–S1 level disc herniation and subsequently underwent L5–S1 discectomy. Individuals with anterolisthesis were excluded from this study. One hundred twenty-five individuals between 2001 and 2004 were identified for inclusion in this study.

MRI scans

MRI images of the lumbar spine were viewed and evaluated on a digital monitor using eFilm Software (Merge eMed, Milwaukee, WI, USA). Clinical scans were collected so there was no predefined magnet strength or acquisition protocol. All images were done supine.

Vertebral measurements and assessment

There are many published methods for determining the amount of listhesis radiographically (expressed in millimeters of subluxation or percent slippage) [10–15]. Retrolisthesis in this study was determined by measuring the position of the vertebral body of L5 relative to S1 on the central-most T1 sagittal magnetic resonance image. The central sagittal image was determined by presence of the lumbar spinous processes within the view, having a symmetrical progression of MRI images from laterally based foraminal views to the central image and having the largest measured value for the anteroposterior diameter of L5 and S1 vertebral bodies. Points were then placed along the posterior margins of L5 and S1 on the central sagittal image to measure the amount of backward slippage to the nearest 0.1 mm. All measurements were performed electronically. Percent retrolisthesis was calculated by dividing the backwards subluxation of L5 by the anteroposterior diameter of S1.

T1 and T2 axial and sagittal images were also used to assess for degenerative changes at the L5–S1 level. Three areas of L5–S1 evaluated for degenerative changes included the disc space, vertebral endplates, and posterior elements. Loss of disc signal intensity on T2 imaging (signifying disc dehydration) was classified in this article as a sign of early disc degeneration and categorized as

a degenerative change. Vertebral endplates were assessed for degenerative changes and classified under the Modic scale. For analytical purposes, stratification between Modic one, two, and three changes was not done in this article, and all Modic changes were combined and categorized collectively as a degenerative change of the vertebral endplates. Signs of posterior element degenerative changes included signs of facet joint arthropathy and ligamentum flavum hypertrophy. Stratification between different posterior element degenerative changes was not performed, and all changes were collectively classified together as a sign of posterior element degenerative change.

SPORT study surveys

Information obtained from the surveys included basic demographics; lifestyle variables; medical history; medical status; emotional status; and patient self-assessment of low back pain, leg pain, sciatica, and other symptomology. Answers given allowed calculation of Short Form-36 (SF-36) health status questionnaire, mean leg pain score (rated 0–6, 0 being not bothersome and 6 extremely bothersome), mean back pain score (rated 0–6, 0 being not bothersome and 6 extremely bothersome), and Sciatica Bothersome Index (rated 0–24, 0 being not bothersome and 24 being extremely bothersome).

Definition of retrolisthesis and symptomology

Measurement for posterior subluxation was done on all patients. Percent subluxation was calculated for any individual with greater than or equal to 3 mm of posterior displacement. A cutoff point of 3 mm was chosen because this criterion has been used previously both in orthopedic research and clinical practice [3,4,13,16–18]. This 3-mm cutoff corresponded to a slip of 8% that was used as the lower limit to define retrolisthesis. Information on patient symptomology was obtained from the SPORT surveys.

Evaluation of reproducibility

To test for intraobserver reliability, 50 of the 125 cases previously reviewed were picked at random for reevaluation. The reader was blinded as to the results obtained from previous readings. After review, the kappa coefficients for presence or absence of retrolisthesis, T2 disc signal changes, posterior element degenerative changes, and Modic changes were calculated. The kappa coefficient is designed to assess the degree of agreement observed between the readers above and beyond what could be expected by chance agreement alone [19].

Data analysis

Chi-square tests were used to determine the statistical significance for differences between categorical variables. Categorical variables included sex, ethnicity, smoking status, insurance, work status, education history, and workers' compensation. Continuous variables were evaluated by using Student *t* tests to assess statistical significance. Age; body mass index; SF-36 scoring; low back pain; leg pain and sciatica; and sensory, reflex, and motor changes were used in this article as continuous variables.

Results

Reproducibility

The kappa values for all four reviewed parameters showed excellent agreement. The kappa values were as follows: presence of retrolisthesis (1.0), loss of T2 disc signal intensity (0.73), occurrence of posterior element degeneration (0.8), and presence of Modic changes (0.75).

Prevalence and characteristics of retrolisthesis and degenerative changes at L5–S1

The overall prevalence of retrolisthesis at L5–S1 in this study was 23.2% (N=125) (Table 1). No association could be established between individuals with retrolisthesis and those without retrolisthesis when comparing patient age, sex, ethnicity, education level, insurance status, body mass index, and smoking status. However, patients with retrolisthesis were more likely to be receiving workers' compensation than those who did not have retrolisthesis ($p<.023$) (Table 2).

When evaluating for the presence of degenerative changes at L5–S1, the prevalence of posterior degenerative changes, T2 disc signal loss, and Modic changes was 36.3% (n=80), 73.6% (N=106), and 28.6% (N=77), respectively (Table 1). Characteristics of patients with and without these changes were very similar. Those with posterior degenerative changes were less likely to be white, and patients with T2 disc signal loss or Modic endplate changes were older (Table 2). These findings were all found to be statistically significant ($p<.05$).

Prevalence and characteristics of retrolisthesis in combination with degenerative changes at L5–S1

The prevalence of retrolisthesis combined with disc degeneration, posterior degenerative changes, or Modic

Table 1
Prevalence of retrolisthesis and degenerative changes at L5–S1

	# of patients		
	No	Yes	Prevalence (%)
Retrolisthesis	96	29	23.20
Any disc T2 signal loss	28	78	73.60
Posterior degenerative changes	51	29	36.30
Any modic changes	55	22	28.60
Retrolisthesis+any disc T2 signal loss	105	20	16.00
Retrolisthesis+posterior degenerative Changes	119	6	4.80
Retrolisthesis+any modic changes	119	6	4.80

Table 2
Characteristics of individuals with retrolisthesis or segmental degenerative changes at L5–S1

	Retrolisthesis			Any posterior degen change			Any disc T2 signal loss			Any Modic change		
	No (n=96)	Yes (n=29)	p Value	No (n=51)	Yes (n=29)	p Value	No (n=28)	Yes (n=78)	p Value	No (n=55)	Yes (n=22)	p Value
Mean age (SD)	40.1 (10.5)	38.8 (11.6)	0.57	38.2 (9.5)	39 (8)	0.69	34.6 (6.8)	40.4 (11)	0.01	37.9 (11)	44.5 (11.4)	0.02
Male	54 (56%)	20 (69%)	0.31	35 (69%)	17 (59%)	0.47	18 (64%)	44 (56%)	0.62	36 (65%)	13 (59%)	0.61
Race												
White	79 (82%)	26 (90%)	0.47	47 (92%)	21 (72%)	0.01	20 (71%)	67 (86%)	0.22	43 (78%)	20 (91%)	0.45
Black	5 (5%)	2 (7%)		0 (0%)	4 (14%)		4 (14%)	3 (4%)		2 (4%)	1 (5%)	
Asian	0 (0%)	0 (0%)		0 (0%)	0 (0%)		0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Other mixed	7 (7%)	0 (0%)		1 (2%)	3 (10%)		2 (7%)	5 (6%)		6 (11%)	0 (0%)	
No response/unknown	5 (5%)	1 (3%)		3 (6%)	1 (3%)		2 (7%)	3 (4%)		4 (7%)	1 (5%)	
Education												
High school or less	29 (30%)	8 (29%)	0.95	14 (28%)	11 (38%)	0.45	8 (29%)	21 (27%)	0.91	14 (26%)	9 (41%)	0.27
Some college or more	67 (70%)	20 (71%)		36 (72%)	18 (62%)		20 (71%)	56 (73%)		40 (74%)	13 (59%)	
Workers compensation	7 (7%)	7 (25%)	0.023	6 (12%)	4 (14%)	1	4 (14%)	8 (10%)	0.84	5 (9%)	3 (14%)	0.68
Other compensation	12 (12%)	2 (7%)	0.65	7 (14%)	5 (17%)	0.75	5 (18%)	8 (10%)	0.49	8 (15%)	1 (5%)	0.27
Insurance												
None	5 (5%)	3 (11%)	0.21	3 (6%)	1 (3%)	0.69	2 (7%)	4 (5%)	0.37	3 (6%)	1 (5%)	0.52
Employer	83 (86%)	20 (71%)		42 (84%)	25 (86%)		21 (75%)	67 (87%)		45 (83%)	18 (82%)	
Medicare	0 (0%)	1 (4%)		0 (0%)	0 (0%)		0 (0%)	1 (1%)		0 (0%)	1 (5%)	
Medicaid	2 (2%)	1 (4%)		1 (2%)	2 (7%)		2 (7%)	1 (1%)		1 (2%)	1 (5%)	
Private	6 (6%)	3 (11%)		4 (8%)	1 (3%)		3 (11%)	4 (5%)		5 (9%)	1 (5%)	
Mean body mass index (BMI) (SD)	28 (6.1)	28.8 (5.5)	0.54	27.9 (5.8)	28.8 (6.5)	0.55	27.5 (4.8)	28.3 (6.2)	0.54	27.2 (5.6)	29.6 (7.4)	0.12
Smoking												
Smoker	33 (34%)	10 (34%)	0.9	18 (35%)	10 (34%)	0.55	6 (21%)	27 (35%)	0.41	18 (33%)	5 (23%)	0.19
Used to	20 (21%)	5 (17%)		9 (18%)	8 (28%)		6 (21%)	16 (21%)		9 (16%)	8 (36%)	
Never	43 (45%)	14 (48%)		24 (47%)	11 (38%)		16 (57%)	35 (45%)		28 (51%)	9 (41%)	

Table 3
Characteristics of individuals with retrolisthesis and segmental degenerative changes at L5–S1

	Retrolisthesis+posterior degen change			Retrolisthesis+any disc T2/signal loss			Retrolisthesis+any Modic change		
	No (n=119)	Yes (n=6)	p value	No (n=105)	Yes (n=20)	p value	No (n=119)	Yes (n=6)	p value
Mean age (SD)	39.9 (10.9)	38.5 (6.5)	0.76	39.9 (10.5)	39.4 (12.3)	0.86	39.2 (10.2)	52.3 (14)	0.003
Male	71 (60%)	3 (50%)	0.96	62 (59%)	12 (60%)	0.87	68 (57%)	6 (100%)	0.097
Race									
White	100 (84%)	5 (83%)	0.57	88 (84%)	17 (85%)	0.54	99 (83%)	6 (100%)	0.75
Black	6 (5%)	1 (17%)		5 (5%)	2 (10%)		7 (6%)	0 (0%)	
Asian	0 (0%)	0 (0%)		0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Other/mixed	7 (6%)	0 (0%)		7 (7%)	0 (0%)		7 (6%)	0 (0%)	
No response/unknown	6 (5%)	0 (0%)		5 (5%)	1 (5%)		6 (5%)	0 (0%)	
Education									
High school or less	33 (28%)	4 (67%)	0.12	32 (30%)	5 (26%)	0.93	34 (29%)	3 (50%)	0.52
Some college or more	85 (72%)	2 (33%)		73 (70%)	14 (74%)		84 (71%)	3 (50%)	
Workers compensation	12 (10%)	2 (33%)	0.28	11 (10%)	3 (16%)	0.78	13 (11%)	1 (17%)	0.81
Other compensation	13 (11%)	1 (17%)	0.81	13 (12%)	1 (5%)	0.61	14 (12%)	0 (0%)	0.81
Insurance									
None	8 (7%)	0 (0%)	0.86	7 (7%)	1 (5%)	0.17	8 (7%)	0 (0%)	<0.001
Employer	97 (82%)	6 (100%)		88 (84%)	15 (79%)		98 (83%)	5 (83%)	
Medicare	1 (1%)	0 (0%)		0 (0%)	1 (5%)		0 (0%)	1 (17%)	
Medicaid	3 (3%)	0 (0%)		2 (2%)	1 (5%)		3 (3%)	0 (0%)	
Private	9 (8%)	0 (0%)		8 (8%)	1 (5%)		9 (8%)	0 (0%)	
Mean body mass index (BMI) (SD)	28.1 (6)	29.1 (3.4)	0.69	28 (6.1)	29.1 (4.8)	0.45	28.1 (6)	28.7 (4.5)	0.82
Smoking									
Smoker	41 (34%)	2 (33%)	0.97	36 (34%)	7 (35%)	0.79	42 (35%)	1 (17%)	0.014
Used to	24 (20%)	1 (17%)		20 (19%)	5 (25%)		21 (18%)	4 (67%)	
Never	54 (45%)	3 (50%)		49 (47%)	8 (40%)		56 (47%)	1 (17%)	

changes was 16%, 4.8%, and 4.8%, respectively (Table 1). Individuals with both retrolisthesis and Modic changes were older than individuals without both of these disorders. Patients having retrolisthesis and Modic changes were more likely to be smokers and to be receiving Medicare (Table 3).

Relation of retrolisthesis to degenerative changes at L5–S1

Previous case series and biomechanical data have found retrolisthesis to be associated with degenerative conditions ranging from disc degeneration when retrolisthesis is more mild to involving posterior structures when more severe. In our study, we were unable to correlate any association between retrolisthesis and an increased incidence of having disc degeneration, posterior degenerative changes, or Modic degenerative changes (Table 4).

Table 4
Relation of retrolisthesis to segmental degenerative changes at L5–S1

	Retrolisthesis		
	No (n=96)	Yes (n=29)	p value
Posterior degenerative change	23 (38%)	6 (32%)	0.79
T2 signal loss	58 (71%)	20 (83%)	0.33
Modic changes	16 (26%)	6 (40%)	0.34

Relation of retrolisthesis and degenerative changes to preoperative pain and function

When evaluating for differences between patients with and without retrolisthesis, no distinction could be drawn between patient preoperative degree of low back pain, leg pain, and dysfunction relating to decrease in sensation or motor weakness. No differences were found in the sciatica bothersomeness index or SF-36 health scoring either. Individuals with disc degeneration were found to have more leg pain than those without disc degeneration (p=.02) (Table 5).

Relation of retrolisthesis in combination with degenerative changes to preoperative pain and function

No statistical significance was found between the presence of retrolisthesis in conjunction with other segmental changes (disc degeneration, vertebral endplate changes, and posterior element degenerative changes) and the degree of patient preoperative low back pain and physical function; however, patients having retrolisthesis with degenerative vertebral endplate changes did have a lower mental component summary score on SF-36 testing than those without retrolisthesis and vertebral endplate changes (p<.05) (Table 6). However, this subgroup was very small, and the difference must be interpreted cautiously.

Table 5
Pain, function, quality of life assessment of individuals with retrolisthesis or segmental degenerative changes at L5–S1

	Retrolisthesis			Any posterior degen change			Any disc T2 signal loss			Any modic change		
	No (n=96)	Yes (n=29)	p value	No (n=51)	Yes (n=29)	p-value	No (n=28)	Yes (n=78)	p value	No (n=55)	Yes (n=22)	p value
Health/pain scores												
Mean Leg Pain (0–6)	5.2 (1.2)	4.9 (1.3)	0.23	5 (1.2)	5.2 (1.3)	0.67	4.7 (1.8)	5.3 (1)	0.024	5 (1.3)	5.4 (0.9)	0.28
Mean Back Pain (0–6)	4 (1.9)	4.1 (1.8)	0.68	3.8 (2)	4.1 (1.9)	0.53	4.1 (2.1)	3.9 (1.9)	0.78	4.1 (1.9)	4.2 (2.1)	0.78
Sciatica bothersome index (0–24)	17.3 (4.7)	16.8 (5.5)	0.58	16.5 (5.3)	18 (3.7)	0.2	16 (4.6)	18 (4.9)	0.068	17 (5.2)	19.2 (4.2)	0.089
SF-36 health status												
Bodily Pain (BP) Score	21.1 (15.6)	24.6 (18.4)	0.32	22.6 (17.3)	19.7 (13.6)	0.45	20.4 (17)	21.4 (15.8)	0.76	20.9 (17.4)	19.5 (15.6)	0.74
Physical Functioning (PF) Score	30.9 (25.2)	37.1 (19.8)	0.23	31.2 (24.6)	31.9 (22.6)	0.9	38.9 (25)	29.2 (22)	0.055	31.5 (23.8)	24.8 (22.1)	0.26
Physical Component Summary (PCS) Score	29.7 (7.5)	30.3 (6.4)	0.68	29.7 (7.4)	30.4 (6.4)	0.66	31.2 (7.6)	29 (6.7)	0.15	29.4 (7.8)	28 (6.2)	0.45
Mental Component Summary (MCS) Score	40.4 (10.8)	43.1 (11.7)	0.24	42.2 (10.9)	39.3 (11.9)	0.28	39.2 (11)	42.1 (11.2)	0.25	41.5 (10.6)	42 (13.7)	0.84
Oswestry (ODI)	56.4 (19.4)	51.3 (19.9)	0.22	56 (20.7)	57.7 (19)	0.73	51.6 (19.6)	57.8 (18.4)	0.14	56.7 (20.2)	59.7 (20.4)	0.56
EuroQOL (EQ5D)	0.25 (0.3)	0.36 (0.3)	0.13	0.3 (0.3)	0.19 (0.3)	0.14	0.28 (0.3)	0.23 (0.3)	0.49	0.27 (0.4)	0.18 (0.3)	0.33
Symptoms												
Reflexes–Asymmetric Depressed	54 (57%)	12 (43%)	0.28	24 (49%)	16 (55%)	0.64	17 (61%)	38 (50%)	0.45	27 (50%)	13 (62%)	0.44
Sensory–Asymmetric Decrease	52 (54%)	14 (48%)	0.73	29 (57%)	14 (48%)	0.49	15 (54%)	41 (53%)	0.9	31 (56%)	14 (64%)	0.62
Motor–Asymmetric Weakness	39 (41%)	13 (45%)	0.85	21 (41%)	12 (41%)	1	9 (32%)	36 (46%)	0.29	22 (40%)	13 (59%)	0.14

Table 6
Pain, function, quality of life assessment of individuals with retrolisthesis and segmental degenerative changes at L5–S1

	Retrolisthesis+posterior degen change			Retrolisthesis+any disc T2 signal loss			Retrolisthesis+any Modic change		
	No (n=119)	Yes (n=6)	p value	No (n=105)	Yes (n=20)	p value	No (n=119)	Yes (n=6)	p value
Health/pain scores									
Mean Leg Pain (0–6)	5.1 (1.2)	5.2 (1.1)	0.95	5.2 (1.2)	5 (1.1)	0.59	5.1 (1.2)	5.2 (0.8)	0.95
Mean Back Pain (0–6)	3.9 (1.9)	5.3 (0.9)	0.078	4 (2)	4 (1.7)	0.92	4 (1.9)	4.1 (2.4)	0.9
Sciatica Bothersome Index (0–24)	17.2 (4.9)	18.2 (4.5)	0.63	17.1 (4.7)	17.7 (5.8)	0.63	17.1 (4.9)	20.3 (5.3)	0.11
SF-36 health status									
Bodily Pain (BP) Score	22.2 (16.4)	16.8 (12.1)	0.43	21.1 (15.9)	26.5 (18)	0.18	21.7 (16)	26.5 (21.4)	0.48
Physical Functioning (PF) Score	32.3 (24.4)	32.5 (19.2)	0.99	31.8 (24.9)	35.3 (19.5)	0.57	32.4 (24.2)	31.7 (25.8)	0.94
Physical Component Summary (PCS) Score	29.8 (7.3)	30.2 (5.1)	0.88	29.7 (7.5)	30.2 (5.9)	0.81	29.8 (7.2)	29.2 (7.8)	0.84
Mental Component Summary (MCS) Score	41 (10.9)	41 (15.2)	0.99	40.3 (10.9)	45 (11.2)	0.082	40.3 (10.8)	54.8 (6.6)	0.001
Oswestry (ODI)	55.1 (19.5)	58 (22.8)	0.73	56.1 (19.8)	50.9 (18.2)	0.29	55.5 (19.3)	51.3 (26.1)	0.62
EuroQOL (EQ5D)	0.28 (0.3)	0.16 (0.4)	0.41	0.26 (0.3)	0.35 (0.3)	0.28	0.27 (0.3)	0.29 (0.5)	0.92
Symptoms									
Reflexes–Asymmetric Depressed	64 (55%)	2 (33%)	0.55	57 (55%)	9 (47%)	0.73	62 (53%)	4 (80%)	0.45
Sensory–Asymmetric Decrease	63 (53%)	3 (50%)	0.78	57 (54%)	9 (45%)	0.6	63 (53%)	3 (50%)	0.78
Motor–Asymmetric Weakness	49 (41%)	3 (50%)	1	41 (39%)	11 (55%)	0.28	47 (39%)	5 (83%)	0.089

Discussion

Retrolisthesis is thought to cause symptoms because of buckling of the posterior annulus and narrowing of the lateral recesses and neuroforamina, conditions that can both cause nerve root compression. In individuals in whom posterior displacement and motion become severe, additional pain can be caused by the involvement of the facet joints and the development of degenerative facet arthropathy.

Factors affecting the formation and severity of degenerative spondylolisthesis such as sagittal orientation of the lumbar facets, vertebral compression deformities, ligamentous laxity, and the degree of endplate inclination have all been documented in the literature [7–9,13,17,20–24]. Symptoms secondary to degenerative anterolisthesis (forward slippage of one vertebrae on another) can be caused by narrowing of the vertebral canal or neural foramina leading to back pain and occasionally leg pain as well [17,21–23]. Unlike anterolisthesis, little biomechanical information is known about the etiologic factors associated with the formation of retrolisthesis. More recent biomechanical research has shown retrolisthesis to be associated with a reduction of lumbar lordosis, decreased endplate inclination, and loss of segmental disc height and disc degeneration [6]. Although retrolisthesis is often seen in the context of degenerative disease (ie. disc degeneration), we were unable to show any relationship between retrolisthesis and an increased incidence of concomitant segmental degenerative changes (ie, disc degeneration, degenerative vertebral endplates, or degenerative posterior elements).

The current study has several limitations. First, because this is a cross-sectional–designed study, only associations between retrolisthesis and preoperative back pain, back dysfunction, and quality of life can be established. Second, the MRI scans used in this study represent only static evaluations. Evaluation of the lumbar spine using lateral extension radiographs might show patients with a dynamic retrolisthesis that was missed on static films. Third, the number of individuals in several groups is low; therefore, the statistical power to detect associations for those groups is low as well.

This study was successful in addressing some of the initial questions brought forth in the introduction. Although evidence from the literature has found retrolisthesis to be associated with an increased incidence of back pain and impaired back function, in our cohort of operative patients, our results did not show any statistical difference in preoperative back pain and dysfunction when comparing individuals with retrolisthesis (alone or in combination with other segmental degenerative processes) and L5–S1 disc herniations to individuals with L5–S1 disc herniations without retrolisthesis (alone or in combination with other segmental degenerative changes).

However, several questions still remain unanswered. Because our study specifically looked at individuals with disc herniations who later underwent surgery, it is possible that the contribution of pain or dysfunction related to retrolisthesis was far overshadowed by the presence of symptoms because of the concomitant disc herniation. It remains to be

seen whether or not a relation between retrolisthesis and patient pain and function can be established postoperatively once the offending herniated disc is removed. A follow-up study is currently underway to investigate whether retrolisthesis (alone or combined with segmental degenerative changes) has any relationship to patient pain, function, and quality of life after L5–S1 discectomy.

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