

Evaluating the characteristics of spondylolisthesis in low back pain by radiography

Fulya Bakılan¹, Burcu Ortanca¹, Murat Şahin²

¹Department of Physical Medicine and Rehabilitation, Eskisehir City Hospital, Eskisehir, Turkey

²Department of Radiology, Eskisehir City Hospital, Eskisehir, Turkey

ORCID ID of the author(s)

FB: 0000-0003-2943-4833
BA: 0000-0001-5421-0116
MŞ: 0000-0001-8141-507X

Corresponding Author

Fulya Bakılan
Department of Physical Medicine and Rehabilitation, Eskisehir City Hospital, Eskisehir, Turkey
E-mail: fulyabakilan@gmail.com

Ethics Committee Approval

The study was conducted with the approval of the Ethics Committee of the Faculty of Medicine of Eskisehir Osmangazi University (The decision no.: 35, date: 14.07.2020).

All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest

No conflict of interest was declared by the authors.

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Abstract

Background/Aim: In physical therapy and rehabilitation practices, it is important to diagnose radiographic spondylolisthesis for correct choice of exercise in patients with low back pain. There are different results about the rates and the characteristics of spondylolisthesis. The aims of this study were to compare the radiographical findings, and evaluate the frequency and the radiographic characteristics of spondylolisthesis according to gender.

Methods: Nine hundred and four patients with low back pain, who were over 18 years of age with records of age, gender, and lumbar spine radiographs (both anterior and lateral) were included in this retrospective cross sectional study. Three hundred and forty-eight patients (245 females, 103 males) who met our criteria were included in the study and reviewed for age, gender, and anterior/lateral-lumbar spine radiographies. Spine radiographies were assessed for the presence of spondylosis, scoliosis, fracture, flattening of the lordosis, hyperlordosis, sacralization, lumbarization and spondylolisthesis. The spondylolisthesis measurements were made according to the Meyerding Grading Scale. The levels and the pattern of anterior or posterior listhesis, and co-existing radiological findings such as osteophyte, sclerosis, intervertebral disk space narrowing and scoliosis, were noted.

Results: The rate of hyperlordosis ($P=0.003$) and spondylolisthesis ($P=0.012$) were significantly higher in females compared to males. The rate of spondylolisthesis among all patients was 11.4% (female/male ratio:2.95/1). All male patients and 91.5% of female patients with spondylolisthesis had it at the L5-S1 level only. Among all, 90.6% of spondylolisthesis patients had anterolisthesis and 79.1% had grade 1 spondylolisthesis according to Meyerding. The most common radiological findings were sclerosis (95%), osteophytes (62.5%), intervertebral disk narrowing (62.5%), scoliosis (37.5%) in spondylolisthesis patients.

Conclusion: The results of our study showed that hyperlordosis and spondylolisthesis were more common in females. The characteristics of spondylolisthesis include occurring mostly at one level only, being Meyerding grade 1 and showing anterolisthesis pattern. The most frequent coexisting radiological findings were sclerosis, osteophytes, and intervertebral disk narrowing. These result support the idea that the pathogenesis of spondylolisthesis is associated with spondylosis. The rate of spondylolisthesis was higher compared to many previous studies. Before deciding on an exercise, it is important to see the direct radiography of the patient with low back pain.

Keywords: Low back pain, Spondylolisthesis, Spondylosis

Introduction

Spondylolisthesis is defined as the slippage (anterior or posterior) of a vertebral body relative to the next caudad vertebra [1]. It is one of the major causes of low back pain and disability [2], it mostly occurs in the lumbar region and is considered to have two major etiologies: Isthmic and degenerative [1]. Isthmic spondylolisthesis is associated with spondylolysis distinguished by fracture of the pars interarticularis and mostly occurs at L5-S1. Degenerative spondylolisthesis is associated with progressive degeneration of both intervertebral discs and facet joints with aging, and mostly occurs at L4-5 [3]. Despite usually being asymptomatic, neurogenic claudication and neurological symptoms can occur, such as pain in the legs, weakness, numbness due to spinal stenosis.

The incidence of spondylolisthesis is reported as 4-6% [4]. The prevalence of spondylolisthesis among 1147 patients with low back pain was 6% [5]. There are contradictory results about prevalence in males and females, it was 2.7% in elderly males, and 8.4% in elderly females in The Copenhagen Osteoarthritis Study [6]. In another study conducted on the elderly Chinese population, 25% of females and 19.1% of males had spondylolisthesis. There are also conflicting results about its relationship with age [7]. Horikawa et al. reported no significant correlation between the presence of spondylolisthesis and age in Japan [8]; however, Denard et al. reported that spondylolisthesis prevalence increased with age [9].

The pathogenesis of degenerative spondylolisthesis is multifactorial and starts with the degeneration of intervertebral discs and facet joints. Progressive degeneration can lead to instability [10]. Chanchairujira et al. reported that osteophyte formation may cause segment instability [11], and Wang et al. reported that intervertebral disc space narrowing can lead to degenerative lumbar spondylolisthesis [12]. There are also studies about other vertebral pathologies that increase the risk of spondylolisthesis. It was reported that the risk of spondylolisthesis increases four times in the presence of sacralization in L5 [4]. In another study on athletes, stress fractures were the most dominating cause of spondylolysis, which is associated with isthmic spondylolisthesis [13]. In a study investigating the relationship between scoliosis and spondylolisthesis, scoliosis was found in 42% of the patients with symptomatic spondylolisthesis [14].

Previous studies reported conflicting results about the gender-based comparison of radiographical findings. Some of them stated that spondylolysis was more common in males [15], while the others stated otherwise [16]. Also, there are different results about the rates and the characteristics of spondylolisthesis.

In clinical practice, it is necessary to diagnose spondylolisthesis due to the exercise choice. Exercises which are given in spondylolisthesis differ from those needed in other conditions of low back pain [17].

This study aimed to assess radiographical findings in patients with low back pain as well as the frequency and the radiographic characteristics of spondylolisthesis according to gender.

Materials and methods

This retrospective analysis included patients with low back pain evaluated at the Department of Physical Medicine and Rehabilitation in Eskisehir City Hospital (Eskisehir, Turkey) between August 2019 and April 2020. Data were obtained from the hospital database and patient files. The medical records of 904 patients with low back pain (ICD-10: M48.06, M51, M51.0, M51.1, M53.3, M54.5, M54.4) were reviewed for age, gender, lumbar spine radiographs.

Patients over 18 years of age with records of age, sex, and lumbar spine radiographs (both anterior and lateral), were included in the study. Those under the age of 18 years, patients who do not have both anterior and lateral radiographs, and those with lumbar spine radiographs not suitable for accurate assessment were excluded from the study. A total of 348 (245 female, 103 male) patients who met the criteria were included.

Anterior and lateral radiographs obtained from T12 to S1 were interpreted by two physical therapy and rehabilitation specialists for the presence of osteophytes, intervertebral disk space narrowing, spondylosis, scoliosis, fracture, flattening of lordosis, hyperlordosis, sacralization, lumbarization and spondylolisthesis.

The spondylolisthesis measurements were made according to The Meyerding Grading Scale by the same specialists by dividing the slip distance by the caudad body width: No slip: Grade 0, 5-25% slippage: Grade 1, 26-50% slippage: Grade 2, 51-75% slippage: Grade 3, 76-100% slippage: Grade 4, complete slippage: Grade 5. Slips of less than 5% were not considered spondylolisthesis [18]. In our study, degenerative and isthmic spondylolisthesis were not evaluated due to the absence of oblique radiographies, and the results for anterolisthesis and retrolisthesis were present. This study did not differentiate between spondylolisthesis and spondylolytic spondylolisthesis because only lateral radiographs were obtained. Antero- and retrolisthesis are grouped under spondylolisthesis.

A loss of anterior, middle, and posterior vertebral height (>20%) or a crush fracture in the vertebra were evaluated as the presence of vertebral fracture [19]. Sclerosis, disk space narrowing, spur formation (osteophyte) indicated the presence of spondylosis [20]. Lumbar lordosis is defined as the angle between the line passing through the upper end plate of L1 vertebra and the sacral endplate. Normal lumbar lordosis is between 40 and 70 degrees when the L3-4 distance is considered as the peak point. A lordotic angle of less than 40 degrees indicated flattening of the lordosis and more than 70 degrees indicated hyperlordosis [21]. A Cobb angle of more than 10 degrees in the frontal plain was considered scoliosis [22]. Addition of sacral elements by the incorporation of L5 was evaluated as sacralization [23]. Separation of the S1 segment from the S2 segment was evaluated as lumbarization [24].

The study was conducted with the approval of the Council of Ethics of the Faculty of Medicine of Eskisehir Osmangazi University with the decision no 35 on 14.07.2020.

Statistical analysis

IBM SPSS Statistics 22.0 (SPSS Inc., Chicago, Illinois) program was used for statistical analysis. The categorical variables were evaluated with Chi-square tests and presented as numbers (n) and percentages (%). Descriptive statistics were

given as mean (standard deviation [SD]). A *P*-value<0.05 was considered significant.

Results

The radiograph qualities of 348 patients were high enough for analysis. Among them, 245 (70.4%) were females, and 103 (29.6%) were males. The overall mean age of the patients, and those of males and females were 47.7 (16.12) years, 45.6 (17.78) years, and 48.3 (15.79) years, respectively (range: 18-87 years).

Among all, %11.7 of the patients had normal radiographic findings. The most common finding in radiographs was spondylosis (75.8%) in both males (77.6%) and females (75.1%). The number and percentage of other radiological findings was shown in Table 1. Spondylolisthesis were seen in 11.4% of the patients, with a F:M ratio of 2.95:1. The rates of hyperlordosis (*P*=0.003) and spondylolisthesis (*P*=0.012) were significantly higher in females (Table 1).

Table 1: The comparison of radiological findings according to gender

	Female (n=245) (%)	Male (n=103) (%)	P-value	Total (n=348) n (%)
Normal radiography	28 (11.4%)	13 (12.6%)	0.753	41 (11.7%)
Lumbarization	2 (0.8%)	2 (1.9%)	0.728	4 (1.1%)
Sacralization	2 (0.8%)	1 (0.9%)	0.887	3 (0.8%)
Hyperlordosis	28 (11.4%)	2 (1.9%)	0.003	30 (8.6%)
Fracture				
Fracture in L1	6 (2.4%)	5 (4.8%)	0.242	11 (3.1%)
Fracture in L2	3 (1.2%)	5 (4.8%)	0.095	8 (2.2%)
Multiple vertebral fractures	8 (3.2%)	2 (1.9%)	0.147	10 (2.8%)
Total	17 (6.9%)	12 (11.6%)	0.500	29 (8.3%)
Scoliosis	66 (26.9%)	22 (21.3%)	0.274	88 (25.2%)
Flattening of lumbar lordosis	62 (25.3%)	32 (31%)	0.269	94 (27%)
Spondylosis	184 (75.1%)	80 (77.6%)	0.609	264 (75.8%)
Spondylolisthesis	35 (14.2%)	5 (4.8%)	0.012	40 (11.4%)

We detected 43 spondylolistheses in 40 patients. Thirty-two of 35 female patients and all male patients had spondylolistheses at L5-S1 only. All males had Meyerding grade 1 spondylolisthesis, and all were in the form of anterolisthesis. Anterolistheses were seen in 90.6% all spondylolistheses, all single-level anterolistheses were at the L5-S1 in both females and males. Two anterolistheses were at two levels in females (At L2-3 and L5-S1 in one, and at L4-5 and L1-2 in the other patient). Most spondylolisthesis (79.1%) were Meyerding grade 1. Retrolisthesis was seen in only 3 (7.5%) patients, all of which were female and Meyerding grade 1. Two retrolistheses were at the L4-5 level, and the other retrolisthesis patient had slips at two levels (both L2-3 and L5-S1) (Table 2).

Table 2: The vertebral level and the grade of the spondylolisthesis patients

	L1-2 n(%)	L2-3 n(%)	L4-5 n(%)	L5-S1 n(%)	Total
Female					
Anterolisthesis grade 1	1 (2.3%)	1 (2.3%)	1 (2.3%)	22 (51.1%)	25 (58.1%)
Anterolisthesis grade 2				9 (20.9%)	9 (20.9%)
Retrolisthesis grade 1		1 (2.3%)	2 (4.6%)	1 (2.3%)	4 (9.3%)
Male					
Anterolisthesis grade 1				5 (11.6%)	5 (11.6%)
Total	1 (2.3%)	2 (4.6%)	3 (6.9%)	37 (86%)	43 (100%)

The most common coexisting radiological finding was end-plate sclerosis present in almost all patients with spondylolisthesis (95%), followed by osteophytes (62.5%) and intervertebral disc space narrowing (62.5%) (Table 3).

Table 3: Coexistence of other radiological findings according to gender in spondylolisthesis patients

	Spondylolisthesis in Female (n=35) n (%)	Spondylolisthesis in Male (n=5) n (%)	Total (n=40)
Hyperlordosis	5 (14.2)	0	5 (12.5%)
Flattening of the lumbar lordosis	6 (17.1)	0	6 (15%)
Fracture	5 (14.2)	1 (20%)	6 (15%)
Scoliosis	13 (37.1)	2 (40%)	15 (37.5%)
Intervertebral disc space narrowing	20 (57.1)	5 (100%)	25 (62.5%)
Osteophyte	23 (65.7)	2 (40%)	25 (62.5%)
Sclerosis	34 (97%)	4 (80%)	38 (95%)

Multiple findings could be observed in one spondylolisthesis patient

Discussion

The major finding of our study is the nearly doubled rates of lumbar spondylolisthesis in patients with low back pain than previously reported [5]. In the Framingham Heart Study, spondylolisthesis was found in 20.7% of studied population, similar to ours [15]. Another study in China reported the prevalence of spondylolisthesis as 25% among females, and 19.1% among males [7]. The female predominance in that study resembles our results. Although the rates of spondylolisthesis may differ with ethnic difference, it cannot be the major factor. In another study in Turkey, the spondylolisthesis ratio was 5%, less than half reported in our study [25].

Gender-based comparison of radiological findings have revealed conflicting results. Kalichman et al. [15] reported that spondylosis was more common in males, while Lee et al. [16] stated otherwise. In another study, scoliosis was more common among females [26]. Contrary to these studies, we found no significant differences between the genders in terms of spondylosis, scoliosis, and other findings. Only hyperlordosis and spondylolisthesis were more common in females with low back pain. Similar to our study, Stagnara et al. [27] reported that hyperlordosis was more common among females compared to males due to their greater buttock size. Furthermore, the lumbar lordosis angle and spondylolisthesis were related [28].

In our study, spondylolisthesis rate was higher among females. Other studies also reported similar findings, but differences were observed in female/male ratios [6,7,15]. The general belief is that it is approximately four times more common in women [4]. The F:M ratio in our study was 2.95:1. Similar to our study, Horikawa et al. reported the female/male ratio as 2.34:1 in Japan [8]. In a Chinese study, female/male ratio of lumbar spondylolisthesis was 1.3:1 [7] and the Copenhagen Osteoarthritis Study reported it as 6.1:1 [6]. The laxity in joints, pregnancy [29] and oophorectomy [30] are thought to be predisposing factors in spondylolisthesis. Also, intervertebral disc narrowing was more severe in women in some studies [31], which may lead to higher ratios of degenerative spondylolisthesis among women.

In our study, most female patients (91.5%), and all male patients had a slip at a single level. A chinese study reported the rate of multi-level slips as 13.8% among female subjects [7]. Denard et al. reported that 96% of listhesis were only at the vertebral level in 300 elderly males [32].

In previous studies, the rate of anterior spondylolisthesis was higher, similar to our study. Anterolisthesis rate in our study is high among both female and male spondylolisthesis patients (females: 91%, males: 100%) Although the rate in female was

similar to those in the previous studies, the rate in males were slightly higher than the other studies. He et al. reported the same rate (91%) of anterolisthesis with our study in 499 females with spondylolisthesis, however, male anterolisthesis rates (74%) were lower than our study [7]. This may be due to the low number of male patients with spondylolisthesis in our study.

Single spondylolistheses were all at L5-S1. In the Framingham Heart Study, isthmic types were mostly found at the L5-S1 spinal level, while the degenerative types were mostly at the L4-5 level [15]. Isthmic spondylolisthesis is mostly seen in male patients and at the L5-S1 level, and degenerative spondylolisthesis is mostly seen in female patients and at the L4-5 level [4]. Due to the absence of oblique spine radiographs, differentiation of isthmic and degenerative spondylolisthesis could not be evaluated. It is not known which type of spondylolisthesis rate is higher in our study.

Our study showed that all listheses of males and 76.3% listheses of females were Meyerding grade 1. Similar to our results, in many studies, grade 1 listhesis was much more common than the other grades. Denard et al. [32] reported that all listheses were classified as grade 1 according to the Meyerding Scale in 300 elderly men. The Chinese study reported that 94% of female patients with spondylolisthesis were Meyerding grade 1 [7].

There are limited studies investigating the relationship between spondylolisthesis and other radiological findings. It is known that progressive degeneration in intervertebral discs and facet joints and osteophyte formation can lead to pain and segment instability [10]. In our study, the most common radiological findings were sclerosis (95%), osteophytes (62.5%) and intervertebral disk narrowing (62.5%) in spondylolisthesis patients. This supports the idea that the pathogenesis of spondylolisthesis is associated with spondylosis. We also studied the relationship of other radiological findings with spondylolisthesis and found that while fracture rate was not high (15%), scoliosis rate was 37.5%. In published data, there is evidence regarding the relationship between degenerative scoliosis and lateral spondylolisthesis [33]. However, there are limited studies about the relationship of scoliosis and anterior-posterior spondylolisthesis. A study reported 42% scoliosis rate in patients with symptomatic spondylolisthesis [14]. This relationship between scoliosis and spondylolisthesis may be associated with the development of various curves due to the muscle contracture and increased pars interarticularis defects in scoliosis compared to the normal population [34]. It is known that the risk of spondylolisthesis increases four times in the presence of sacralization in L5 [4]; however, we had no patient with sacralization and spondylolisthesis in our study. In another study, the prevalence of sacralization was 5.1% [34], while it was 0.8% in ours. The lack of a relationship may be because of the low number of patients with sacralization.

Limitations

This study has some limitations. First, degenerative and isthmic spondylolisthesis was not investigated due to the absence of oblique radiographs. Also, because of retrospective design, we were not able to evaluate pain levels, functionality, pelvic inclination, or the degree of lordosis. Increased lumbar lordosis may impose additional stress on the spinal ligaments and play a

role in spondylolisthesis pathogenesis. Further studies are needed which evaluate the relationship between degree of lordosis and spondylolisthesis. The strength of our study was not only evaluating the frequency, age and sex distribution, but also evaluating the relationship between spondylolisthesis and other radiological findings.

Conclusion

In this study, the rates and the characteristics of spondylolistheses was presented. In physical medicine and rehabilitation practice, it is important to differentiate spondylolisthesis because the choice of exercise differs accordingly. The rate of spondylolisthesis was higher compared to many previous studies. Most spondylolistheses occurred in females, higher rates of anterolistheses were observed compared to retrolisthesis, and most were grade 1 at the L5-S1 level. The most common radiological findings were sclerosis, osteophytes and intervertebral disk narrowing in spondylolisthesis patients. Our results support the idea that the pathogenesis of spondylolisthesis is associated with spondylosis.

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