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Research Paper: L5 Spondylolysis and Accelerating Osteoarthritic Changes in L5-S1 Facet Joints

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ABSTRACT

Background: Spondylolysis is a defect in the pars interarticularis of the vertebra. The defect changes the biomechanical stresses and probably causes the degenerative process in the adjacent facet joints.

Objectives: In this study, we aimed to assess the effect of L5 spondylolysis on the osteoarthritis process of adjacent L5-S1 facet joints.

Methods: In this cross-sectional cohort study, we assessed 157 cases with a history of low back pain who underwent lumbar computerized tomography scanning of two lower lumbar vertebrae for any reason. The patients with a medical history of vertebral fracture, previous surgery, or infection were excluded. The samples were placed into two groups; 1 (with L5 spondylolysis; 80 cases) and 2 (without spondylolysis; 77 cases). Then, their facet joints osteoarticular severity changes were scored and compared on imaging scans based on observing narrowing, sclerosis, osteophyte formation, and bone cyst.

Results: The difference regarding the frequency of sex was not significant between the two groups. The prevalence rates of narrowing (P<0.001), sclerosis (P=0.032), and osteophyte (P=0.023) were significantly higher in group 1; however, bone cyst showed no significant difference (P=0.365). Data analysis by logistic regression showed that the aging process was more implicated than spondylolysis in increasing the prevalence of arthritic changes, but bone cysts were not associated with degenerative changes (P=0.216).

Conclusion: Facet joint degenerative changes (including joint space narrowing, osteophyte, subchondral sclerosis, and cyst) in cases with L5 spondylolysis were not significantly different from those without it. These changes were more affected by the aging process than the spondylolysis itself.

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1. Introduction

Lumbar spondylolysis is a defect in the pars interarticularis of the vertebra with a prevalence of 5%-6% in the general population [1, 2]. Numerous studies throughout the world have already proved no significant relationship between spondylolysis and Low Back Pain (LBP) [3-6]. The structural defect in the spondylotic vertebra creates changes in applied stress to its different parts. Normally, 80% of the weight pressure is applied to the lumbar vertebral body and 20% to the posterior elements [7, 8]. In the cases with spondylolysis, the connection between anterior and posterior elements of the vertebra is disrupted, and a floating lamina occurs. Consequently, it seems logical that the stress applied on the anterior part of the vertebrae should be more and, conversely, less stress on the posterior part [9, 10]. It is expected that in patients with spondylolysis, the probability and severity of osteoarthritis of the adjacent facet joints are less than in patients without spondylolysis. However, little scientific evidence supports a link between spondylolysis and osteoarthritis of the facet joints.

Objectives

In this study, we aimed to evaluate the effect of L5 spondylolysis on the osteoarthritis process of the adjacent L5-S1 facet joints.

2. Methods

Following the approval of the Institutional Review Board and Ethics Committees (record No. of IR.MUMS.MEDICAL.REC.1398.079, approval date: 2019-03-05 by School of Medicine - Mashhad University of Medical Sciences), this cross-sectional research project was performed on 157 mature patients who were referred to Orthopedic Spine Clinic, Imam Reza Hospital, Mashhad City, Iran with chronic LBP of more than three months. Their lumbar Computerized Tomography (CT) scannings were taken during their diagnostic work-up (not especially for this project) from September 2018 to November 2019. We excluded those cases with unilateral spondylolysis, spinal level other than L5, ages <18 or >60 years, history of trauma, previous lumbar surgery, infection, spondylolisthesis, tumor, or deformity. These patients were usually the cases with refractory LBP that Magnetic Resonance Imaging (MRI) or plain radiography could not explain the underlying disease or the cases that were lumbar surgical candidates. But radiologic evaluation could not detect the structural details required for preoperative measures (due to obesity, congenital anomalies, or spondylolysis defects).

We placed the patients in two groups: group 1 (with L5 spondylolysis) and group 2 (control group with intact pars interarticularis). On CT scans with three different planes (sagittal, coronal, and axial), similar to Goda's study, we arbitrarily defined four radiologic criteria for severity of osteoarticular changes at L5-S1 facet joints: disk space narrowing, osteophyte, subchondral sclerosis, and cyst. We gave a point to each criterion and placed them in a spectrum from 0 to 4 scores to define the osteoarticular severity of the facet joints [9]. The scoring processes were carried out and recorded by both the senior orthopedic and radiologic authors separately.

Statistical analysis

The recorded data were analyzed by SPSS version 20. The characteristics of the subjects were presented by descriptive statistical methods, including central indices, dispersion, and frequency distribution in the form of appropriate tables. In the case of normal data distribution, the independent t test was used to compare quantitative variables between the two groups; otherwise, we used the Mann-Whitney test. The Chi-square test and, if necessary, Fisher exact test and regression analysis were used to compare qualitative variables between the two groups. In all calculations, P values of 0.05 or less were considered significant.

Table 1. Demographic characteristics of the patients

Groups / Indexes		1 (Lysis+)	2 (Lysis-)	P
Number		77	80	
Age, Mean±SD (y)		51.9±9.4	39.9±12.3	<0.001
Sex, No.(%)	Male	44(57.1)	47(58.7)	0.873
	Female	33(42.9)	33(41.3)	

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Table 2. Prevalence of osteoarticular changes and degenerative scores

Groups	Index	1 (Lysis+)	2 (Lysis-)	P
Radiologic changes, No.(%)	Joint space narrowing	56(72.7)	35(43.8)	<0.001
	Subchondral sclerosis	17(22.1)	8(10)	0.032
	Osteophyte	20(26)	9(11.2)	0.023
	Subchondral cyst	7(9.1)	5(5.1)	0.365
Overall degenerative score, No.(%)	Score 0	16(20.8)	43(53.8)	<0.001
	Score 1	29(37.7)	25(31.3)	
	Score 2	26(33.8)	7(8.8)	
	Score 3	5(6.5)	3(3.8)	
	Score 4	1(1.3)	2(2.5)	

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Table 3. Results of univariate logistic regression test to investigate the effect of age on various degenerative changes

Dependent Variables	Independent Variables	Regression Coefficient	Standard Error	Odds Ratio	95% Confidence Interval	P
Narrowing	Spondylolysis	0.528	0.393	1.696	0.785-3.660	0.179
	Age	0.069	0.017	1.071	1.036-1.107	<0.001
Sclerosis	Spondylolysis	0.036	0.526	1.037	0.370-2.908	0.945
	Age	0.103	0.033	1.109	1.038-1.184	0.002
Osteophyte	Spondylolysis	0.353	0.493	1.423	0.542-3.741	0.474
	Age	0.069	0.026	1.071	1.018-1.127	0.008
Cyst	Spondylolysis	0.154	0.731	1.167	0.278-4.894	0.833
	Age	0.044	0.036	1.045	0.975-1.120	0.216

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3. Results

We studied 77 cases with spondylolysis and 80 cases with intact pars interarticularis. Although in comparing the groups, sex distribution was not different, older patients were significantly more prevalent in the spondylolysis group (Table 1).

Table 2 presents the prevalence of degenerative changes in two groups and overall scores. As the table shows, the rate of both osteoarticular changes and overall degenerative scores were significantly higher in the spondylolysis group compared with another group. However, the frequency of bone cysts was not significantly different between the two groups (P=0.365).

Because the age index was significantly different between the two groups, we used logistic regression to eliminate the effect of this confounding factor. This test showed that with increasing age, the chance of degenerative changes, including joint space narrowing, sclerosis, and osteophyte, significantly increased. In other words, the results are age-related, and no association was detected between spondylolysis and degenerative changes (Table 3). However, the prevalence of bone cysts was not associated with age (P=0.216).

In addition, based on the scores of degenerative changes, the patients were conventionally divided into two categories; without degenerative changes (0, 1) and with degenerative changes (2, 3, 4). The regression test results also showed that the above grouping was not associated

Table 4. Results of logistic regression test to investigate the effect of age on the presence of degenerative change

Dependent Variables	Independent Variables	Regression Coefficient	Standard Error	Odds Ratio	95% Confidence Interval	P
Degenerative changes	Spondylolysis	0.662	0.438	0.882	1.038-1.184	0.438
	Age	0.081	0.023	1.085	1.036-1.107	<0.001

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with spondylolysis, and only age was associated with degenerative changes. Table 4 shows the relevant details.

4. Discussion

The results of our study showed that the rate of degenerative changes in cases with spondylolysis was significantly higher than those without it. The significant difference in these changes was mainly related to narrowing the joint space, sclerosis, and osteophyte. Subchondral cyst formation did not show a significant difference between the two groups. The secondary result of our study showed that all the mentioned degenerative changes, including narrowing of the joint space, sclerosis, and osteophyte, increased with age. However, the age factor had no significant effect on the prevalence of cysts. Finally, the logistic regression test found out that degenerative changes were mainly due to age, and the existence of spondylolysis had no relation with degenerative changes in adjacent facet joints.

A similar study on 214 cases in Japan (107 patients with spondylolysis and 107 sex- and age-matched cases without spondylolysis) examined degenerative changes prevalence and severity in their adjacent facet joints [9]. The results showed that the frequency of joint space narrowing, sclerosis, osteophyte, and cyst in the group with spondylolysis was significantly higher than those in the group without spondylolysis. Also, in quantitative analyses related to the 5-point scoring system (similar to what we used to assess the severity of osteoarthritis), the mean score of degenerative changes in the group with spondylolysis was significantly higher than the group without it. In contrast to this, in our study, the prevalence and severity of osteoarthritis were more influenced by the patient's age than by the mere presence of the pars defect. In the Goda study, the cases were sex- and age-matched, but in our study, the patients with L5 spondylolysis were older. This difference may be one reason (not all the reasons) for these different findings, and future studies will probably discover more details of this challenging issue.

There are also other predisposing factors for accelerating facet joint arthrosis, including lumbar hypo- or hyper-lordosis, body mass index, congenital anomalies, spinal deformities (kyphosis or scoliosis), facet tropism, facet orientation, age, sex (female), trauma, race (African American), genetics, occupational issues, smoking, and so on. However, in this study, we exclusively investigated the effect of spondylolysis on osteoarthritis of adjacent facet joints and did not investigate others [11-17].

Age has already been known as a strong predisposing factor for facet joint osteoarthritis [18, 19]. In this study, we confirmed this factor in the existence and severity of lumbar facet joint osteoarthritis. Facet orientation is the angle of the facet joints in the transverse plane relative to the sagittal plane, while facet tropism is demarcated as disproportionateness of the left and right facet joint angles, with one joint having a more sagittal orientation than the other [20]. Kalichman et al. investigated 3529 cases to find a relationship between facet orientation and tropism with osteoarthritis of the facet joints [21]. Their study showed an essential relationship between osteoarthritis of the facet joints and sagittal facet orientation at the L4-L5 (not L3-L4 or L5-S1), but facet tropism had no role in the prevalence or severity of facet arthrosis at any level.

Masharawi et al. showed that facet joints in patients with spondylolysis in the lumbar vertebrae are more frontally oriented, which causes the lumbar vertebrae to move along the sagittal axis [22]. This event causes the facet joints' surfaces to be more under pressure as the vertebrae move in the sagittal plane and are prone to more degenerative changes. However, in our study, the age factor was a predisposing factor, and spondylolysis itself had no role in developing these degenerative changes.

Our study has several Limitations. One of the weaknesses of our study was the lack of evaluation of patients' clinical complaints. Also, our patients were mainly of a particular race and socioeconomic class and limited in number; therefore, the results may not be generalized to the whole population. However, our study examined degenerative changes in the lumbar facet joint in detail, and indices like joint space narrowing, osteophyte, subchondral sclerosis, and cyst, were carefully evaluated. One of the important strengths of our study was the elimination of the age confounding factor from the initial statistical results, which could help clarify the matter significantly.

5. Conclusion

Our study showed that facet joint degenerative changes (including joint space narrowing, osteophyte, subchondral sclerosis, and cyst) in cases with spondylolysis were not significantly different from those without it. These changes were more affected by the aging process than spondylolysis itself.

Ethical Considerations

Compliance with ethical guidelines

This article was approved by the Vice-Chancellor for Research and Technology of Mashhad University of Medical Sciences. The Research Ethics certificate was recorded (IR.MUMS.MEDICAL.REC.1398.079).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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