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Anatomical factors and pathological parts of isthmic fissure and degenerative lumbar spondylolisthesis

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Abstract: The pathogenesis of isthmic spondylolisthesis and degenerative spondylolisthesis is different. It is unclear whether there is a difference between the anatomical factors and the site of the disease. To investigate whether there is a difference between the anatomical factors and the location of the disease in patients with degenerative spondylolisthesis and adult lumbar spondylolisthesis. A retrospective analysis of 183 cases of degenerative spondylolisthesis with complete imaging data and adult lumbar spondylolisthesis from May 2012 to February 2015, including 92 cases of degenerative spondylolisthesis (degeneration group) 91 cases of isthmic spondylolisthesis (isthmic fissure group). The lumbar spondylolisthesis, the slippage rate and the slippage distance of the two groups were measured, and the comparison between groups was performed. The age of the isthmus fissure group, the lumbar lordosis angle, and the width of the vertebral isthmus were smaller than that of the degenerative group (P<0.05). The angle between the articular surface of the facet joint and the sagittal plane and the slip index were larger than those of the degenerative group (P<0.05). There was no significant difference in the inclination angle of the tibia between the two groups (P>0.05). The difference in the prevalence of isthmus spondylolisthesis and degenerative spondylolisthesis was statistically significant (P<0.05). Patients with isthmic spondylolisthesis have a good L5. Degenerative spondylolisthesis occurs in L4. The spondy index of patients with isthmic spondylolisthesis is greater than that of degenerative lumbar spondylolisthesis. Vertebral isthmus dysplasia or morphological changes (slim) is schizophrenia important factor in the pathogenesis of lumbar spondylolisthesis L4. The smaller angle between the intervertebral articular surface and the sagittal plane, and the increase of lumbar lordosis angle play a role in the formation of degenerative lumbar spondylolisthesis L5.

Keywords: Isthmic spondylolisthesis; Degenerative slippage; Anatomical factors; Incidence site

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1. Introduction

Clinically, lumbar spondylolisthesis is one of the important causes of low back pain. According to whether the vertebral isthmus is continuously divided into isthmic spondylolisthesis and degenerative lumbar spondylolisthesis, the pathogenesis is not the same[1-3]. In recent years, numerous studies have shown that the location of lumbar spondylolisthesis and the abnormality of the sagittal anatomy of the spine may play a crucial role in the development of lumbar spondylolisthesis[4-8]. Compared with normal people, patients with isthmic fissure and degenerative spondylolisthesis showed greater pelvic angles of incidence.

Because the pathogenesis of isthmic spondylolisthesis and degenerative spondylolisthesis is different, whether there is a difference between the parameters of the sagittal plane of the spine pelvis and the location of the disease, it is not clear, this paper is different by multi-slice spiral CT scan. Influencing factors of type lumbar spondylolisthesis intervertebral articular surface and Sagittal angle, lumbar lordosis angle, sacral tilt angle, slip index, etc. were compared and analyzed. The role of related anatomical factors in the pathogenesis of different types of lumbar spondylolisthesis was preliminarily were obtained.

2. Subjects and Methods

2.1. Subjects

A retrospective analysis of patients with lumbar spondylolisthesis or degenerative spondylolisthesis from the Department of Spinal Surgery, Qingdao University Hospital (Huangdao Branch) from March 2016 to March 2018. All patients were diagnosed by enquiring detailed medical history, physical examination and imaging examination. Imaging examinations included: standing X-ray film of the full spine, supine lumbar vertebrae, left and right oblique X-ray film, lumbar CT scan, three-dimensional reconstruction and lumbar MRI plain scan (Figure 1, 2).

183 patients with lumbar spondylolisthesis were enrolled and divided into two groups according to the type of lumbar spondylolisthesis. Isthmus split 91 patients in the group, including 27 cases of I degree slip, 64 cases of II degree slip; 20 cases of L4 slip, L5 slip 71 cases. 92 cases of degenerative group, including 31 cases of I degree slip, 61 cases of II degree slip; L4 slip 70, L5 slipped in 22 cases.

Inclusion criteria: >18 years old, isthmic fissure or degenerative lumbar spondylolisthesis disease. The patient were received the inform consent to the treatment and trial protocol. Exclusion criteria: spine-pelvic malformation, metabolic bone disease, patients with lumbar spondylolisthesis who underwent spinal surgery.

Figure 1. Lumbar spondylolisthesis and x-ray performance (L5 vertebral isthmus fracture).

Figure 2. X-ray findings of lumbar degenerative spondylolisthesis (L4 vertebral body detachment, no isthmus).

2.2. Method

Imaging measurement using Philips 256-slice spiral at line volume scanning, scanning range from the upper edge of L1 vertebral body to the lower edge of S1 vertebral body, respectively. Bone window, soft tissue window to observe vertebral body, intervertebral joint and intervertebral disc, parallel vector image reconstruction, measuring pelvic parameters, sagittal sagittal parameters, and slippage parameters were used. Measurements of all parameters were performed using Surgimap Spine software (Version: 1.1.2.293, Nemaris Inc, New York).

Evaluation of slip degree: Using the 1932 Meyerding indexing standard, I degree, the head end vertebral body is displaced forward or backward by ≤25% on the vertebral body at the end of the vertebral body. II degree, the vertebral body shift is 26%-50%. III degree, vertebral body displacement is 51%-75%. IV degree, vertebral body displacement ≥76%.

Pelvic parameter measurement[9]: The angle between the line connecting the midpoint of the humeral endplate and the center of the bilateral femoral head and the perpendicular to the endplate of S1. The angle formed by the line connecting the midpoint of the humeral endplate and the center of the bilateral femoral head with the horizontal perpendicular. The angle between the end plate tangential line and the horizontal line on the humerus.

Figure 3 PI is the angle of incidence of the pelvis, that is, the angle between the midpoint of the upper edge of S1 and the center point of the femoral head and the perpendicular line of the upper edge of S1 (when the bilateral femoral heads do not coincide, take the midpoint of the line connecting the two central points) SS is the angle of inclination of the tibia, that is, the angle between the upper edge of S1 and the horizontal line; PT is the angle of inclination of the pelvis, that is, the angle between the line from the midpoint of the upper edge of S1 to the center point of the femoral head and the plumb line.

Slip-related parameters[10-12] were the angle b between the endplate tangential line of the L1 vertebral body and the endplate tangential line on S1, the angle between the upper subvertebral endplate (gh) of the slippage segment and the line of the lower vertebrae endplate (jd), the vertical distance CD between the back end C of the lower vertebra endplate and the upper end D of the lower tail vertebra, the percentage of the detachment distance to the lower endplate length EF and joint facet and sagittal plane angle C1\C2 (Figures 4-5). All cases were independently diagnosed by two senior doctors and consistent diagnosis results were obtained.

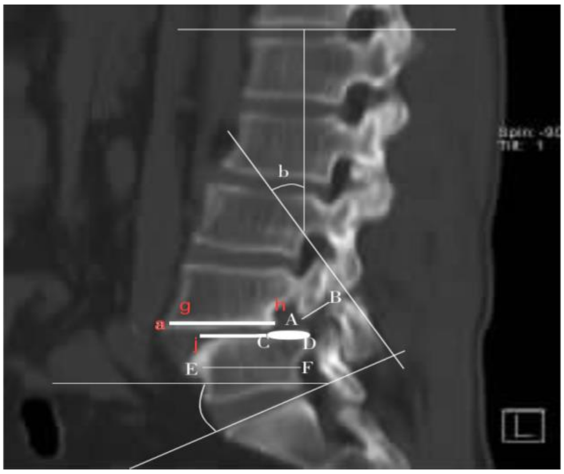

Figure 4. Slip-related parameters: Tibial tilt angle; lumbar lordosis angle; vertebral isthmus width; lumbar spondylolisthesis; slip distance; slip rate.

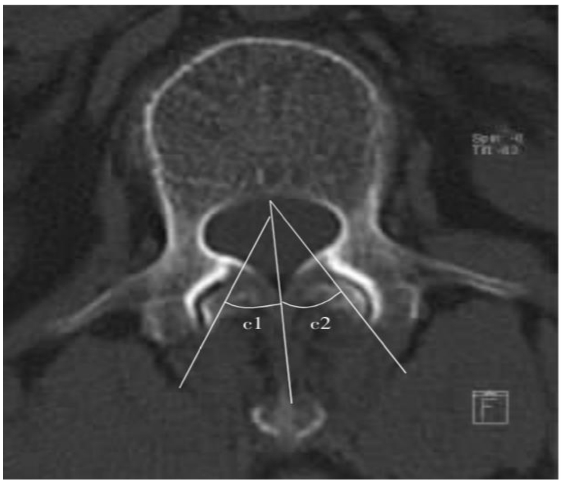

Figure 5. Angle between the articular surface of the facet joint and the sagittal plane c=(c1+c2)/2.

2.3. Main observation indicators

The vertebral-pelvic sagittal morphological indexes of the two groups were measured on the lateral CT of the standing position, including lumbar lordosis angle, pelvic angle of incidence, pelvic inclination angle, and sacral inclination angle. At the same time, the lumbar spondylolisthesis, the slippage rate and the slippage distance of the two groups were measured, and the comparison between groups was performed.

2.4. Statistical analysis

Statistical analysis was performed using SPSS 18.0 (Chicago, IL, USA) software. The chi-square test was used to compare the type and location of lumbar spondylolisthesis, with α=0.05 as the test standard. The comparison between the parameters of the pelvic pelvis and the slippage of the isthmic group and the degenerative group was performed by independent sample t test. The comparison between the type, location and anatomical factors of lumbar spondylolisthesis was performed by independent sample t test.

3. Results

3.1. Comparison of baseline data

The chi-square test was used to compare the type, location and age of lumbar spondylolisthesis[13,14]. There was no significant difference in age (P>0.05). There was significant difference in type and location (P<0.05), Table 1.

Table 1. Relationship between type, location and gender of lumbar spondylolisthesis

Cases	Degenerate group（N=92）	Isthmic fissure group（N=91）	x^2	P
art（L4/L5)	68/24	54/27	4.372	0.037
Gender（M/F）	46/46	42/49	0.271	0.603

3.2. Spinal-pelvic sagittal parameters and slip-related parameters

The lumbar lordosis angle and slip angle were significantly lower in the degenerative group than in the isthmic fissure group (P<0.01); the sagittal plane balance in the degenerative group was significantly greater than that in the isthmus group (P<0.01). There was no significant difference in the angle of pelvic incidence, pelvic tilt angle and sacral tilt angle between the two groups of patients with articular surface and sagittal plane angle and slippage index (P<0.01), Table 2 and Table 3.

Table 2. Comparison of anatomical factors between isthmus and degenerative groups

Parameter	Degenerate group (N=92)	Isthmic fissure group (N=91)	t	P
Lumbar lordosis (°)	30.670±4.918	49.214±9.418	-16.670	<0.01
Sagittal balance (°)	3.010±1.283	1.308±0.448	12.007	<0.01

Pelvic angle of incidence (°)	53.917±6.183	52.757±8.067	1.091	0.277
Pelvic tilt angle (°)	24.665±9.315	23.770±6.619	0.750	0.454
Tibial tilt angle (°)	39.400±8.856	38.562±8.112	0.668	0.505
Slippery angle (°)	5.145±2.217	11.000±3.663	-13.064	<0.01
Slip index (%)	0.235±0.037	0.302±0.319	-13.236	<0.01
Slip distance (cm)	2.064±0.544	2.738±0.516	-8.602	<0.01
Vertebra isthmus width (mm)	9.105±0.412	8.425±0.468	10.440	<0.01
Angle of articular surface and sagittal plane (°)	36.338±4.841	45.866±5.372	-12.606	<0.01

Table 3. Comparison of anatomical factors between l4 and l5 groups

Parameter	L4				L5			
	Degenerate group	Isthmic fissure group	t	P	Degenerate group	Isthmic fissure group	t	P
Lumbar lordosis (°)	30.581±4.438	49.587±9.931	13.065	<0.01	30.921±6.182	48.6708±8.719	8.651	<0.01
Sagittal balance (°)	3.128±1.268	1.33±0.459	10.835	<0.01	2.675±1.293	1.276±0.435	5.119	<0.01
Pelvic angle of incidence (°)	54.315±5.385	53.139±7.730	0.950	>0.05	52.792±8.061	52.200±8.614	0.269	>0.05
Pelvic tilt angle (°)	26.543±8.909	25.596±5.464	0.722	>0.05	19.346±8.491	21.105±7.300	0.862	>0.05
Tibial tilt angle (°)	40.093±9.622	37.915±7.892	1.343	>0.05	37.438±5.930	39.505±8.443	1.123	>0.05
Slippery angle (°)	5.049±2.063	10.513±3.514	10.125	<0.01	5.417±2.637	11.711±3.806	7.066	<0.01
Slip index (%)	23.472±36.422	30.442±33.335	10.90	<0.01	0.238±0.378	0.300±0.299	6.832	<0.01
Slip distance (cm)	2.038±0.530	2.769±0.489	7.818	<0.01	2.138±0.587	2.695±0.557	3.378	<0.01
Vertebra isthmus width (mm)	9.140±0.356	8.428±0.460	9.360	<0.01	9.008±0.536	8.422±0.485	4.428	<0.01
Angle of articular surface and sagittal plane (°)	37.271±5.035	45.607±4.721	9.406	<0.01	33.696±3.005	46.244±6.252	10.483	<0.01

4. Discussion

There was no significant difference in the parameters of the pelvis between the isthmic group and the degenerative group (P>0.05), which means that patients with isthmic spondylolisthesis and degenerative spondylolisthesis have similar pelvic morphology[15,16]. The article is consistent with the study by Liu Yong et al[17], and further large samples confirm that there is no difference in pelvic parameters between the two types of diseases.

Previous studies have discussed the factors related to the type, location and age of lumbar spondylolisthesis[18]. The narrow part between the superior and inferior articular processes is called the isthmus of the vertebral arch, where the bone structure is relatively weak. According to literature analysis[19-20], most patients with isthmic spondylolisthesis are caused by fatigue fractures in the lumbar isthmus due to congenital development, chronic strain or stress injury. From the mechanical analysis, the negative gravity of the lumbar spine is divided into two components: one is the compressive component acting on the intervertebral joint consistent with the long axis of the lumbar spine; the other is acting parallel to the long axis of the vertebral body acting on the isthmus leading to dislocation. The component of the vertebral isthmus of the relatively weak bone structure is prolonged and broken. After walking upright, the person forms the normal physiological lordosis of the lumbar spine, the sacral vertebrae are physiologically kyphosis, and the junction of the lumbar and atlas is a turning point. From the L3-L5 vertebral body long axis and the horizontal plane gradually increased angle (L3 close to the horizontal), so that its forward shear force gradually increased, that is, L5 has a greater forward slip shear force. Therefore, the isthmus is prone to cracking, and the site of the disease is more common in L5. The age of patients with isthmic spondylolisthesis is mostly middle-aged. At this stage, there is no significant difference between male and female patients in terms of anatomy and endocrine of lumbar vertebrae. Therefore, there is no significant gender difference in the incidence of lumbar spondylolisthesis. The cause of isthmic spondylolisthesis is not very clear, mainly congenital, dysplastic, traumatic and other factors. At present, most of the former are considered to be the main factors. Some cases may be associated with spina bifida, transitional vertebrae and other spinal deformities. The lumbar isthmus refers to the stenosis between the superior and inferior articular processes, where the bone structure is relatively weak. The difference in the width of the isthmus of the two groups in this study was statistically significant (P<0.01), again demonstrating the abnormal development of the isthmus It is an important factor in the etiology of isthmic spondylolisthesis. Due to the fracture of the vertebral arch isthmus in patients with isthmic lumbar spondylolisthesis, the important factors that maintain the stability of the spine are lost, and the important restraining force that prevents the vertebral body from slipping forward is weakened. The patient has early onset and long course of disease, so the vertebral body. The slip distance is usually greater than the degenerative lumbar spondylolisthesis (P<0.01). Patients with isthmic fissure group showed greater lumbar lordosis than degenerative. For isthmic spondylolisthesis, the narrow part between the superior and inferior articular processes of the lumbar spine was weak. After one or both sides of the fracture, the upper lumbar vertebrae leaned forward. The lower vertebral body is tilted backwards, which makes the weight of the lumbosacral spine form a forward stress. In addition, the higher pelvic incident angle value often means a higher value of the sacral tilt angle, and the lumbar lordosis angle is also compensatory. Increase[18]. The waist is the closest to the humerus, which indicates that L5-S1 has a higher shearing force. The shearing force acting on the isthmus is larger than the degenerative slippage, so the isthmic spondylolisthesis is more likely to be applied at L5.

The incidence of degenerative lumbar spondylolisthesis was mostly L4. In this study, the degenerative group was closer to the sagittal plane than the isthmus joint of the isthmus group. This change reduced its effectiveness in the coronal direction. The area, thus reducing the resistance to the forward sliding of the vertebrae, results in a weakened ability to resist forward shear, and ultimately does not counteract the tendency of the adjacent vertebral body to slip forward in the forward direction. This sagittal arrangement of joint morphology may be associated with the occurrence of degenerative lumbar spondylolisthesis. And because L4 is located at the apex of the lumbar vertebrae, the transverse process is small. The support of the ligament is less. The L5 transverse process is usually the largest in the lumbar spine, and its wide, sturdy posterior attachment and iliac ligament are strongly supported, so it is less prone to slip. The L4 internal dip angle is too small and it is in the middle of the lumbar lordosis [21-26]. The range of motion is the largest. Long-term excessive or poor posture is prone to chronic fatigue injury. In addition, in the intervertebral disc degeneration, joint capsule relaxation, intervertebral joint degeneration and other factors caused by abnormal stress migration, it is easy to cause spinal instability and slip. In this study, the pelvic incident angles of degenerative spondylolisthesis and isthmic spondylolisthesis were higher than those of normal people.

5. Conclusion

In summary, degenerative lumbar spondylolisthesis has similar pelvic morphology to adult patients with lumbar spondylolisthesis. Due to the different etiology, the spine-pelvic sagittal compensation mechanism is different, and the two show different The sagittal shape of the spine. Lumbar spondylolisthesis is more likely to occur in L5, while degenerative spondylolisthesis is more prone to L4. Before developing a surgical plan for these two types of patients, it is necessary to consider the existence of these differences to obtain a satisfactory clinical repair effect.

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