ORIGINAL

Radiographic comparison between male and female patients with lumbar spondylolysis

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Abstract : We studied the lumbar spines of 117 adults (39 women and 78 men) with spondylolysis unrelated to low back pain using multidetector computed tomography (CT). Of the 117 subjects with spondylolysis, including five with multiple-level spondylolysis, there were 124 vertebrae with spondylolysis. In adult lumbar spines with unilateral spondylolysis, there was no significant difference between the incidence of spondylolisthesis in female and male subjects. However, in those with bilateral spondylolysis, there was a significantly higher incidence of spondylolisthesis in female subjects (90.9%) than in males (66.2%). Furthermore, females with bilateral spondylolysis had significant more slippage than males. Lumbar index and lumbar lordosis were not significantly different between male and female subjects, and did not significantly correlate with slippage. In conclusion, to treat acute spondylolysis in adolescents, it is important to obtain bony union at least unilaterally, especially in female subjects, to prevent further slippage. J. Med. Invest. 57 : 133-137, February, 2010

Keywords **:** *spondylolysis, computed tomography, spondylolisthesis, gender differences, lumbar spines*

INTRODUCTION

Spondylolysis is thought to be a stress fracture of the pars interarticularis that occurs frequently in adolescent sports players (1, 2). Some patients with spondylolysis concomitantly have various deformities of the lumbosacral region, including slippage of the vertebral body (spondylolisthesis) and/or wedging deformity (1, 3-10). Saraste reported that approximately 80% of patients with spondylolysis showed slippage, and in one-fifth of these patients the slippage exceeded 25% (11). Wedging deformity of the spondylolytic vertebra has been interpreted as an expression of the hypoplastic dysplasia and commonly accepted as the cause of spondylolysis and spondylolisthesis. Sairyo et al. examined 46 adolescent athletes with symptomatic spondylolysis and reported that slippage at L5 was correlated with the maturity of the lumbar spine : slippage occurred in the immature spine and ceased when the vertebra matured. Furthermore, they suggested that the wedge deformity of the affected vertebra might be a result rather than a cause of slippage (12).

There have been reports that adolescent females have a higher degree of slippage at diagnosis than adolescent males (9, 13). There have been no reports of gender differences of these deformities associated with spondylolysis in the general population. Here, we studied the lumbar spine in adults with spondylolysis unrelated to low back pain using

Received for publication November 26, 2009 ; accepted January 12, 2010.

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multidetector computed tomography (CT), and focused on gender differences.

MATERIALS AND METHODS

Subjects

A total of 117 patients (39 women and 78 men) with lumbar spondylolysis were included in this study. Mean patient age was 63.0 (22 to 87) years. All patients also participated in our preliminary study (14). Patients underwent abdominal and pelvic CT with a single multidetector CT scanner for reasons unrelated to lower back pain. All CT scans were ordered from the departments of general surgery and gynecology. Each CT was performed using a 16-detector-row CT scanner (Aquilion 16 ; Toshiba Medical Systems, Tokyo, Japan) with a rotation time of 0.5s, helical pitch 15 (beam pitch 0.9375), tube voltage 120 kV, and tube current 10-400 mA (SD 8.5). The acquired images were reconstructed into CT images (thickness 1 mm) utilizing the CT image reconstruction function of FC10 or FC 50. Observation was performed using a 1-mm slice thickness MPR (multi planer reconstruction) image with Aquarius NET Server (TeraRecon, Inc ; San Mateo, CA, USA) under standard bone settings (window width 2200, window level 200). S.T. (certified radiologist) and T.S.(certified spine surgeon) reviewed all images, and diagnosis and measurements were achieved by consensus. An institutional review board exemption was obtained for reviewing the imaging studies along with the indications for the studies and the official CT reports.

Measurements

In the previous studies, measurements have been made using plain X-ray films ; there have been no previously defined criteria for using CT images for these measurements. We measured degree of translation (mm), slippage (%), lumbar index (%), and lumbar lordosis (degrees), which are thought to be associated with spondylolysis. All measurements were performed using mid-sagittal and mid-coronal sections (Figure 1).

Degree of slippage

Measurements of degree (translation) of slippage were conducted on mid-sagittal view (Figure 2-a). Percent slippage was measured according to the method described by Wiltse and Winter (15).

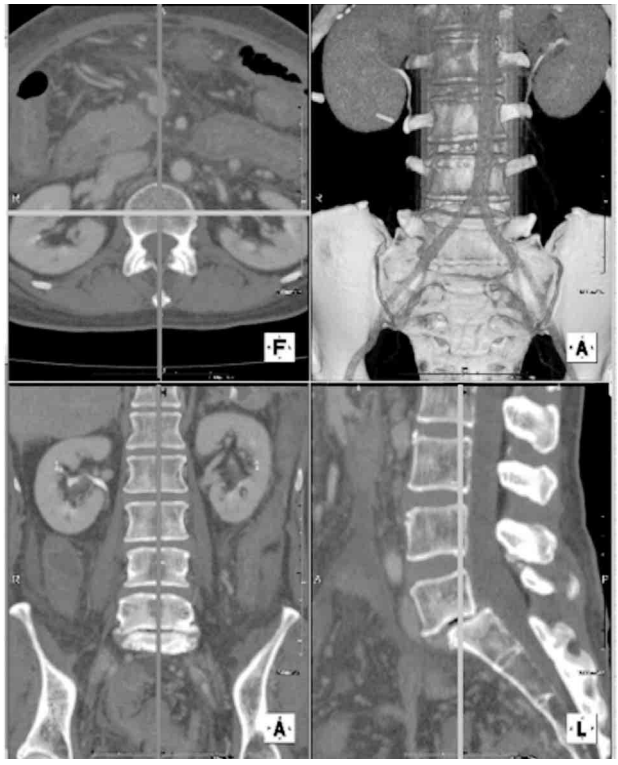

Figure 1. All measurements were performed using 1-mm slice thickness CT scans reconstructed with Aquarius NET Server, and using mid-sagittal and mid-coronal sections.

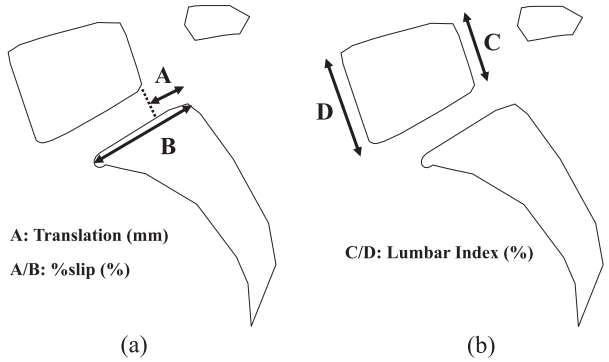

Figure 2. (a) Measurements of degree (translation) of slippage were conducted on mid-sagittal view. Percent slippage was measured according to the method described by Wiltse and Winter (15).
(b) Lumbar index was measured on mid-sagittal view.

Lumbar index

Lumbar index (LI) was measured on mid-sagittal view (Figure 2-b).

Lumbar lordosis

Lumbar lordosis was measured from the superior endplate of L1 to the superior endplate of S1 (Figure 3).

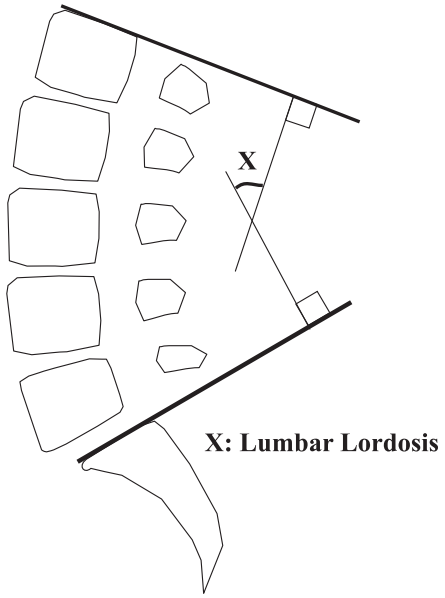

Figure 3. Lumbar lordosis was measured from the superior endplate of L1 to the superior endplate of S1.

Statistical analysis

The statistical analyses were performed using cross tabulation (Fisher's exact probability test), Mann-Whitney U test in comparisons of nonparametric variables, and Spearman's rank correlation coefficient test. The statistical difference was recognized as significant, when the p value was less than 0.01.

RESULTS

In the 117 patients with spondylolysis, including five with multiple-level spondylolysis, there were 124 affected vertebrae. There were 26 vertebrae with unilateral spondylolysis and 98 vertebrae with bilateral spondylolysis.

Of the 26 subjects with unilateral spondylolysis, nine were female (mean age : 60.9± 15.4 years, range : 37-83 years) and 17 were male (mean age : 67.4± 14.4 years, range : 22-87 years). In the group of 17 males, there were two subjects (11.8%) with slippage, whereas none (0%) of the nine females had slippage. However, there was no statistically significant difference (Fisher's exact probability test) between these results (Table 1).

Table 1.

Unilateral Spondylolysis	Men	Women
Subjects with Slippage	2 (11.8%)	0 (0%)
Subjects without Slippage	15 (88.2%)	9 (100%)
Total	17	9

Of the 98 subjects with bilateral spondylolysis, there were 33 females (mean age : 61.4± 12.2 years, range : 35-83 years) and 65 males (mean age : 63.1± 14.4 years, range : 24-87 years). Of the 65 male subjects there were 43 (66.2%) with slippage, whereas of the 33 female subjects there were 30 (90.9%) with slippage. There was a statistically significant difference between the two groups ($p< 0.01$, Fisher's exact probability test) (Table 2).

Table 2.

Bilateral Spondylolysis	Men	Women	
Subjects with Slippage	43 (66.2%)	30 (90.9%)	
Subjects without Slippage	22 (33.8%)	3 (9.1%)	*
Total	65	33	

*$p< 0.01$, Fisher's exact probability test

In subjects with unilateral spondylolysis, translation, percent slippage, lumbar index, and lumbar lordosis were not significantly different between male and female subjects (Table 3). Whereas in those with bilateral spondylolysis, translation and percent slippage were statistically significantly greater in females than in males ($p< 0.01$, Mann-Whitney U test) (Table 4).

In subjects with bilateral spondylolysis, there was no correlation between age and slippage (translation, percent slippage) (Spearman's rank correlation coefficient test) in either males or females. Additionally, there were no correlations between lumbar index or lumbar lordosis and slippage (translation, percent slippage).

Table 3.

	Unilateral Spondylolysis : 26 Vertebrae		
	Men (n=17)	Women (n=9)	
Translation (mm)	0.41± 1.17	0	N. S.
Percent slippage (%)	1.26± 3.45	0	N. S.
Lumbar Index (%)	83.32± 6.72	80.90± 7.50	N. S.
Lumbar Lordosis (degree)	52.23± 8.23	49.20± 12.70	N. S.

Table 4.

	Bilateral Spondylolysis : 98 Vertebrae		
	Men (n=65)	Women (n=33)	
Translation (mm)	4.06± 3.41	5.64± 2.90	*
Percent slippage (%)	11.42± 9.65	17.75± 9.93	*
Lumbar Index (%)	80.73± 9.11	79.30± 8.58	N. S.
Lumbar Lordosis (degree)	51.00± 7.92	52.07± 10.17	N. S.

*p< 0.01, Mann-Whitney U test

DISCUSSION

In adult lumbar spines with unilateral spondylolysis, there was no significant difference between the incidence of spondylolisthesis in male (11.8%) and female subjects (0%). However, in those with bilateral spondylolysis, there was a significantly higher incidence of spondylolisthesis in females (90.9%) than in males (66.2%). Slippage in patients with spondylolysis is thought to be most prevalent during the growth period and rare thereafter (8, 13). Sairyo et al. retrospectively reviewed immature patients with spondylolysis to elucidate the relationship between the maturity of the lumbosacral spine and the development of slippage (12). They concluded that slippage was more prevalent in individuals of a younger skeletal age, whose lumbar spine was immature, and it ceased once the growth period was over and the vertebra had matured. From these results, it appears that to treat acute spondylolysis in adolescence it is important to obtain bony union at least unilaterally, especially in female subjects.

In the present study, female subjects with bilateral spondylolysis had significantly more slippage than males. This result was consistent with previous reports. It has previously been reported that girls have a greater degree of slippage at diagnosis (13, 16). Based on these results, we suggest that a young female patient with acute bilateral spondylolysis will have a predisposition to severe slippage. The etiology of this difference between males and females is unknown. Slippage of the lumbar spine with spondylolysis occurs between the osseous and cartilaginous end plates because the site including the growth plate is the weakest link to anterior shearing forces (17-20). Therefore, we speculate that there is a gender difference in the fragility of the growth plate.

Lumbar index (wedging deformity) and lumbar lordosis showed no significant difference between male and female subjects. Furthermore, they did not significantly correlate with slippage. Ikata et al. have reported that, in adolescents, wedging deformity was not evident if the pars defect was in the early stages of development but the degree of deformity increased as the stage of the pars defect advanced and as slippage developed (17). These results suggest that although the wedging deformity could correlate with slippage during the growth period, it does not affect the degree of slippage after maturation of the spine. There is controversy regarding possible correlation between lumbar lordosis and slippage (21-24) ; consistent with the present study, some reports have demonstrated no correlation (23, 24).

The main limitation of this study was that, as it is based on CT scans, slippage and lumbar lordosis were evaluated under static conditions. Therefore, dynamic changes in slippage by lumbar flexion/extension were not evaluated, and lumbar lordosis was not measured in the standing position.

In conclusion, in subjects with bilateral spondylolysis, there was a significantly higher incidence of spondylolisthesis in female subjects than in males. Furthermore, female subjects with bilateral spondylolysis had significantly more slippage than males. Therefore, to treat acute spondylolysis in adolescents, it is important to obtain bony union at least unilaterally to prevent further slippage, especially in female subjects.

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