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• 专题报道 •

退变性腰椎滑脱的脊柱-骨盆矢状位参数特征分析

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[摘要] **目的** 探讨退变性腰椎滑脱患者脊柱-骨盆矢状位参数特征及这些参数与腰椎滑脱的关系。**方法** 选择2016年6月至2018年6月我院收治的42例退变性腰椎滑脱患者(退变性腰椎滑脱组)和58例无滑脱的退变性腰椎疾病患者(对照组)作为研究对象。收集两组研究对象的一般资料,在脊柱全长正侧位X线片上测量骨盆倾斜角(PT)、骨盆投射角(PI)、骶骨倾斜角(SS)、腰椎前凸角(LL)、胸腰椎后凸角(TLK)、胸椎后凸角(TK)、矢状面躯干偏移(SVA)等矢状位参数,比较两组研究对象一般资料和矢状位参数的差异。以腰椎滑脱率为因变量,脊柱-骨盆矢状位参数为自变量,采用logistic回归模型分析腰椎滑脱程度的危险因素。**结果** 两组研究对象年龄、性别、身高、体质量差异均无统计学意义($P>0.05$)。退变性腰椎滑脱组和对照组患者PT、PI、SS、LL、TLK、SVA差异均有统计学意义($P<0.05$),而两组间TK差异无统计学意义($P>0.05$)。对退变性腰椎滑脱组进行logistic回归分析,发现LL、PT是影响腰椎滑脱程度的危险因素($P<0.05$)。**结论** 退变性腰椎滑脱患者矢状位参数PT、PI、SS、LL、TLK、SVA明显改变,LL、PT是影响腰椎滑脱程度的危险因素。

[关键词] 退变性腰椎滑脱;脊柱-骨盆参数;滑脱率;脊柱矢状位平衡

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Analysis of spinopelvic sagittal parameters in degenerative lumbar spondylolisthesis

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[Abstract] **Objective** To explore the characteristics of spinopelvic sagittal parameters in degenerative lumbar spondylolisthesis patients and the relationship between these parameters and lumbar spondylolisthesis. **Methods** From Jun. 2016 to Jun. 2018, 42 patients with degenerative lumbar spondylolisthesis (DLS) were enrolled in study group, and 58 degenerative lumbar disease patients without spondylolisthesis were enrolled in control group. The general characteristics of the patients were collected. The sagittal parameters, including pelvic tilt (PT), pelvic incidence (PI), sacral slope (SS), thoracic kyphosis (TK), thoracolumbar kyphosis (TLK), lumbar lordosis (LL) and sagittal vertical axis (SVA), were measured on lateral X-ray films of full-length spine. The differences of general characteristics and sagittal parameters were compared between the two groups. With the lumbar spondylolisthesis rate as dependent variable and the spinopelvic sagittal parameter as independent variable, logistic regression model was used to analyze the risk factors of lumbar spondylolisthesis. **Results** There were no significant differences in the age, gender, height or body mass of the patients between the two groups (all $P>0.05$). There were significant differences in the PT, PI, SS, LL, TLK and SVA between the DLS group and the control group (all $P<0.05$), but there was no significant difference in the TK ($P>0.05$). Logistic regression analysis showed that LL and PT were risk factors of lumbar spondylolisthesis (both $P<0.05$). **Conclusion** The sagittal parameters (PT, PI, SS, LL, TLK and SVA) in the patients with DLS are significantly changed. LL and PT are the risk factors of lumbar spondylolisthesis.

[Key words] degenerative lumbar spondylolisthesis; spinopelvic parameters; spondylolisthesis rate; sagittal balance of spine

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退变性腰椎滑脱是中老年人群常见的腰椎退变性疾病,多发于50~60岁人群,以女性多见^[1]。退变性腰椎滑脱的病因和发病机制复杂,由多种因素导致相邻椎体滑移而产生一系列症候群,最常见于L₄~L₅节段^[2]。随着滑脱的进展,退变性腰椎滑脱患者脊柱和骨盆形态会发生代偿性改变以维持脊柱的平衡,在此过程中,脊柱-骨盆矢状位参数也会发生改变^[3-8]。骨盆参数主要包括骨盆倾斜角(pelvic tilt, PT)、骨盆投射角(pelvic incidence, PI)和骶骨倾斜角(sacral slope, SS)等,脊柱参数主要包括胸椎后凸角(thoracic kyphosis, TK)、胸腰椎后凸角(thoracolumbar kyphosis, TLK)、腰椎前凸角(lumbar lordosis, LL)和矢状位躯干偏移(sagittal vertical axis, SVA)等。脊柱与骨盆在解剖结构上相连接,两者的矢状位参数相互关联、协调、匹配。本研究通过比较退变性腰椎滑脱患者与无滑脱的退变性腰椎疾病患者的脊柱-骨盆矢状位参数,分析影响腰椎滑脱程度的危险因素,为指导手术治疗、恢复腰椎滑脱矢状位参数的平衡提供参考。

1 资料和方法

1.1 研究对象 选择我院2016年6月至2018年6月收治的退变性腰椎滑脱患者42例作为退变性腰椎滑脱组。纳入标准:(1)患者无腰椎骨折、外伤、峡部裂、肿瘤、结核等病史;(2)无腰椎及骨盆手术史;(3)有完整站立位脊柱全长X线片资料。排除标准:(1)特发性脊柱侧凸患者;(2)既往脊柱手术史者;(3)患有感染或肿瘤的患者。对照组为我院门诊就诊的退变性腰椎疾病无滑脱患者58例。纳入标准:退变性腰椎疾病,无滑脱,无腰椎骨折、外伤、峡部裂、肿瘤、结核、手术等病史,有完整站立位脊柱全长X线片资料。本研究经海军军医大学(第二军医大学)长海医院伦理委员会审批。

1.2 数据采集 收集两组患者的年龄、性别、身高、体质量等一般资料。在脊柱全长正侧位X线片上测量脊柱-骨盆矢状位参数,包括LL(L₁椎体上终板与L₅椎体下终板之间的Cobb角)、TLK(T₁₀椎体上终板与L₂椎体下终板之间的Cobb角)、TK(T₅椎体上终板与T₁₂椎体下终板之间的Cobb角)、SVA(C₇椎体中点矢状铅垂线与

S₁椎体后上角的水平距离)、PT(股骨头中心连线中点和骶骨终板中点的连线与铅垂线之间的夹角)、PI(股骨头中心连线中点和骶骨终板中点的连线与骶骨终板垂线之间的夹角)、SS(水平线与骶骨终板切线之间的夹角)。采用腰椎滑脱率评价腰椎滑脱程度,腰椎滑脱率根据Taillard方法^[9]计算(滑脱椎体与下位椎体后缘距离除以下位椎体上终板矢状径)。

1.3 统计学处理 采用SPSS 19.0软件进行统计学分析。计量资料经SPSS 21.0软件Q-Q图分析符合正态分布,以 $\bar{x} \pm s$ 表示,组间比较采用独立样本 t 检验;计数资料以例数表示,组间比较采用 χ^2 检验。以腰椎滑脱率为因变量,脊柱-骨盆矢状位相关参数为自变量,采用logistic回归模型分析与退变性腰椎滑脱程度相关的危险因素。检验水准(α)为0.05。

2 结果

2.1 一般资料 退变性腰椎滑脱组纳入42例退变性腰椎滑脱患者,其中男17例、女25例,年龄为(59.43±5.99)岁,滑脱椎体包括L₃3例、L₄17例、L₅22例,典型脊柱全长正侧位X线片见图1。对照组纳入无滑脱的退变性腰椎疾病患者58例,其中男24例、女34例,年龄为(60.09±6.20)岁。两组研究对象年龄、性别、身高、体质量差异均无统计学意义(P 均>0.05),见表1。

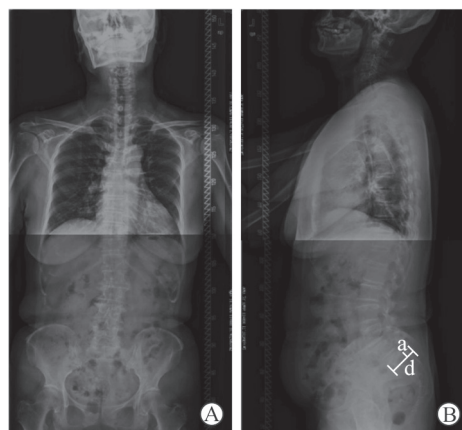


图1 1例66岁女性L_{4/5}滑脱患者脊柱全长正位(A)和侧位(B)X线片

Fig 1 Anterior posterior (A) and lateral (B) spine X-ray showing L_{4/5} spondylolisthesis in a 66 years old female patient a: Relative slippage distance of upper vertebral body on lateral radiograph; d: Sagittal diameter of superior endplate of lower vertebral body

表 1 两组患者一般资料的比较

Tab 1 Comparison of general information between two groups

Variable	DLS group <i>N</i> =42	Control group <i>N</i> =58	Statistic	<i>P</i> value
Age (year), $\bar{x} \pm s$	60.79 $\pm$ 6.20	59.47 $\pm$ 5.79	<i>t</i> = -1.019	0.278
Male/female <i>n</i>	17/25	24/34	χ^2 = 0.008	0.928
Height <i>h</i> /cm, $\bar{x} \pm s$	158.95 $\pm$ 5.78	160.91 $\pm$ 5.92	<i>t</i> = -0.130	0.102
Body mass <i>m</i> /kg, $\bar{x} \pm s$	65.24 $\pm$ 6.85	67.67 $\pm$ 7.24	<i>t</i> = 1.698	0.093

DLS: Degenerative lumbar spondylolisthesis

2.2 两组脊柱-骨盆矢状位参数的比较 退变性腰椎滑脱组患者 PT、PI、SS、LL、TLK、SVA 均大于对照组且差异均有统计学意义 (*P* 均 < 0.05), 但两组间 TK 差异无统计学意义 (*P* > 0.05), 见表 2。

表 2 两组患者脊柱-骨盆矢状位参数的比较

Tab 2 Comparison of spinopelvic sagittal parameters between two groups

Variable	DLS group <i>n</i> =42	Control group <i>n</i> =58	<i>t</i> value	<i>P</i> value
PT $\theta(^{\circ})$, $\bar{x} \pm s$	24.71 $\pm$ 8.15	8.91 $\pm$ 7.91	9.733	<0.001
PI $\theta(^{\circ})$, $\bar{x} \pm s$	67.62 $\pm$ 12.61	43.66 $\pm$ 9.68	10.750	<0.001
SS $\theta(^{\circ})$, $\bar{x} \pm s$	42.88 $\pm$ 7.63	34.76 $\pm$ 8.31	4.991	0.001
LL $\theta(^{\circ})$, $\bar{x} \pm s$	-52.38 $\pm$ 9.54	-42.86 $\pm$ 9.10	-5.060	<0.001
TLK $\theta(^{\circ})$, $\bar{x} \pm s$	-5.07 $\pm$ 9.86	2.74 $\pm$ 7.79	-4.424	<0.001
TK $\theta(^{\circ})$, $\bar{x} \pm s$	19.71 $\pm$ 8.95	21.16 $\pm$ 8.88	-0.798	0.427
SVA <i>l</i> /cm, $\bar{x} \pm s$	18.76 $\pm$ 15.43	-0.26 $\pm$ 31.82	3.481	0.001

DLS: Degenerative lumbar spondylolisthesis; PT: Pelvic tilt; PI: Pelvic incidence; SS: Sacral slope; LL: Lumbar lordosis; TLK: Thoracolumbar kyphosis; TK: Thoracic kyphosis; SVA: Sagittal vertical axis

2.3 影响腰椎滑脱程度的危险因素 退变性腰椎滑脱组患者采用 logistic 回归模型分析影响腰椎滑脱率的危险因素, 结果发现 LL、PT 是影响腰椎滑脱率的危险因素 (*P* < 0.05), 见表 3。

表 3 Logistic 回归模型分析影响 DLS 患者腰椎滑脱率的危险因素

Tab 3 Risk factors of spondylolisthesis rate in DLS patients by logistic regression analysis

Variable	<i>B</i>	<i>SE</i>	β	<i>t</i> value	<i>P</i> value
Constant	-24.045	9.551		-2.518	0.016
PT	0.733	0.230	0.525	3.183	0.003
LL	-0.844	0.107	-0.707	-7.878	<0.001
TLK	-0.008	0.580	-0.007	-0.051	0.960
TK	0.036	0.142	0.029	0.256	0.799
SVA	0.056	0.081	0.076	0.694	0.492

DLS: Degenerative lumbar spondylolisthesis; PT: Pelvic tilt; LL: Lumbar lordosis; TLK: Thoracolumbar kyphosis; TK: Thoracic kyphosis; SVA: Sagittal vertical axis; *B*: Regression coefficient; *SE*: Standard error; β : Standardized regression coefficient

3 讨 论

正常脊柱呈现 S 型生理曲度, 矢状位参数能很好地反映脊柱的平衡、代偿和生物力学改变情况^[10]。脊柱和骨盆共同维持躯干平衡, 退变性腰椎滑脱患者的脊柱和骨盆形态会出现代偿性改变, 从而维持躯干平衡。为了探讨退变性腰椎滑脱患者脊柱-骨盆参数特征, 本研究纳入 42 例退变性腰椎滑脱患者及 58 例无滑脱的退变性腰椎疾病患者, 两组研究对象在年龄、性别、身高、体质量方面差异

均无统计学意义, 具有可比性。对两组研究对象的脊柱-骨盆矢状位参数进行比较, 发现退变性腰椎滑脱组患者的 PT、PI、SS、LL、TLK、SVA 均大于对照组, 差异均有统计学意义 (*P* 均 < 0.05)。这与 Schuller 等^[11]的研究结果相似。这些结果提示在腰椎滑脱的进展中, 随着滑脱程度增加 SVA 增大, 为了维持 SVA 平衡, 腰椎 LL 增大, 而腰椎前凸的改变伴随骶骨的倾斜^[12], SS 相应发生了改变, 由于 PT 和 SS 在评价骨盆形态上的效果一致^[13], 根据几何关系 $PI = PT + SS$ ^[14-15], PI 也会增

大。胸腰段的改变也易引起腰椎前凸改变,加速腰椎退变^[16]。TK 在两组之间差异无统计学意义,退变性腰椎滑脱患者腰椎前凸的改变需要通过改变胸椎后凸的角度来维持脊柱的矢状位平衡,但老年患者由于胸椎相对固定、活动度小,早期滑脱的患者该代偿性改变不明显,因此导致两组 TK 无明显差异。

大量研究表明,LL 是需要与 PI 匹配的。Legaye 和 Duval-Beaupère^[17]研究发现高 PI 需要高的 LL 匹配, Park 等^[18]的研究发现 LL 与 PT、SS 之间存在线性相关, Vialle 等^[19]研究发现 LL 与 PI、SS 之间有显著的相关性, Labelle 等^[20]发现退变性腰椎滑脱患者的 LL、PT、SS 是增大的。本研究结果与目前公认的低度滑脱的发生机制一致: PI 增高, 伴随的 SS 增大, LL 代偿性增加^[21-23]。由于 $PI=PT+SS$, PT 与 SS 在评价骨盆的位置时具有相同意义, 因此在进行 logistic 回归分析滑脱程度的危险因素时, 我们选择骨盆参数 PT 与脊柱矢状位参数 LL、TLK、TK、SVA 进行分析, 结果显示 LL 和 PT 是影响滑脱程度的危险因素。

现阶段手术治疗仍是退变性腰椎滑脱的重要治疗方法, 但是退变性腰椎滑脱的发病机制、病因仍不明确, 需要进一步大样本随访研究。本研究主要是为手术治疗恢复脊柱-骨盆矢状位平衡提供参考依据, 防止 PI 与 LL 出现不匹配, 不能维持矢状位的 SVA^[24]; PT 及 SS 的改变说明出现骨盆倾斜, 在手术中重建骨盆的 PT 能很好地改善骨盆的矢状位序列, 维持脊柱矢状位的平衡^[25-27]。术前需要对脊柱-骨盆矢状位参数进行详细分析, 指导术中脊柱-骨盆矢状位平衡的重建, 以获得满意的手术效果。

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