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• 专题报道 •

腰椎融合术后邻近节段病变与脊柱-骨盆矢状位参数的相关性

袁佳滨, 王 超, 杨长伟, 李孝明, 刘 澍, 林徐苗, 李 明, 石志才*

海军军医大学(第二军医大学)长海医院骨科脊柱外科, 上海 200433

[摘要] **目的** 分析腰椎融合术后邻近节段病变(ASDis)与脊柱-骨盆矢状位参数的相关性,并探讨其危险因素。**方法** 纳入2013年1月至2017年10月在海军军医大学(第二军医大学)长海医院骨科脊柱外科因腰椎融合术后ASDis行翻修手术的患者为ASDis组,匹配同期行腰椎融合手术且经过相同时间随访未发生明显ASDis的患者为对照组。回顾性分析两组患者的病例资料,比较两组患者一般资料及末次随访时的脊柱-骨盆矢状位参数的差异,前者包括年龄、性别、体质量指数(BMI)、随访时间及初次手术病因,后者包括胸椎后凸角(TK)、矢状位躯干偏移(SVA)、腰椎前凸角(LL)、手术节段腰椎前凸角(sLL)、骨盆入射角(PI)、骨盆倾斜角(PT)、骶骨倾斜角(SS)等。**结果** 共纳入ASDis组患者25例,对照组患者50例,两组患者的年龄、性别、BMI、随访时间及初次手术病因差异均无统计学意义(P 均 >0.05)。ASDis组患者LL、sLL、SS均小于对照组($36.00^\circ \pm 5.44^\circ$ vs $43.88^\circ \pm 10.62^\circ$, $17.80^\circ \pm 5.79^\circ$ vs $27.62^\circ \pm 6.74^\circ$, $27.50^\circ \pm 5.30^\circ$ vs $31.06^\circ \pm 7.48^\circ$, P 均 <0.05),PT大于对照组($26.12^\circ \pm 8.24^\circ$ vs $18.80^\circ \pm 7.67^\circ$, $P<0.01$),两组间TK和PI差异均无统计学意义(P 均 >0.05);同时,ASDis组中SVA >50 mm、PI与LL的差值($PI-LL$) $\geq 10^\circ$ 及sLL占LL比例(RL) $<60\%$ 的患者比例均高于对照组(18/25 vs 21/50, 16/25 vs 11/50, 21/25 vs 17/50, P 均 <0.05)。**结论** 腰椎融合术后矢状位失衡与ASDis的发生密切相关,手术节段前凸恢复不良导致邻近节段腰椎代偿性后凸可能是引起腰椎融合术后ASDis的原因之一。

[关键词] 腰椎融合术;邻近节段病变;脊柱-骨盆参数;病例对照研究

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Correlation between spinopelvic sagittal parameters and adjacent segment disease after lumbar fusion

YUAN Jia-bin, WANG Chao, YANG Chang-wei, LI Xiao-ming, LIU Shu, LIN Xu-miao, LI Ming, SHI Zhi-cai*

Department of Spine Surgery, Changhai Hospital, Naval Medical University (Second Military Medical University), Shanghai 200433, China

[Abstract] **Objective** To analyze the correlation between adjacent segment disease (ASDis) after lumbar fusion and spinopelvic sagittal parameters, and to explore the risk factors. **Methods** From Jan. 2013 to Oct. 2017, the patients undergoing revision surgery for ASDis after lumbar fusion in Changhai Hospital of Naval Medical University (Second Military Medical University) were enrolled as ASDis group, and the patients who did not have ASDis after lumbar fusion during the same follow-up period were taken as controls. The clinical data of the patients in the two groups were retrospectively analyzed. The differences of the general data (age, gender, body mass index [BMI], follow-up time and the etiology of the first operation) and the spinopelvic sagittal parameters (thoracic kyphosis [TK], sagittal vertical axis [SVA], lumbar lordosis [LL], segmental lumbar lordosis [sLL], pelvic incidence [PI], pelvic tilt [PT] and sacral slope [SS]) were compared between the two groups. **Results** There were 25 patients in the ASDis group and 50 patients in the control group. There were no significant differences in the age, gender, BMI, follow-up time or the etiology of the first operation between the two groups (all $P>0.05$). Compared with the control group, the LL, sLL and SS were significantly lower in the ASDis group ($36.00^\circ \pm 5.44^\circ$ vs $43.88^\circ \pm 10.62^\circ$, $17.80^\circ \pm 5.79^\circ$ vs $27.62^\circ \pm 6.74^\circ$, $27.50^\circ \pm 5.30^\circ$ vs $31.06^\circ \pm 7.48^\circ$; all $P<0.05$), while the PT was significantly greater ($26.12^\circ \pm 8.24^\circ$ vs $18.80^\circ \pm 7.67^\circ$, $P<0.01$). There were no significant differences in the TK or PI between the two groups (both $P>0.05$). Meantime, the proportion of patients with SVA >50 mm, the difference

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[作者简介] 袁佳滨, 硕士生. E-mail: smmuyuan@163.com

*通信作者(Corresponding author). Tel: 021-31161697, E-mail: zhicaishi@vip.sina.com

of PT and LL ($PT-LL \geq 10^\circ$), and the ratio of sLL to LL ($RL < 60\%$) were significantly higher in the ASDis group than those in the control group (18/25 vs 21/50, 16/25 vs 11/50, 21/25 vs 17/50; all $P < 0.05$). **Conclusion** The sagittal imbalance after lumbar fusion is closely associated with ASDis, and compensatory kyphosis of adjacent lumbar segments due to surgical segmental lordosis may be one of the causes of ASDis after lumbar fusion.

[Key words] lumbar fusion; adjacent segment disease; spinopelvic parameters; case-control studies

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腰椎融合术是治疗腰椎退变性疾病的标准术式。近年来,手术技术和内固定材料研究取得了长足进展,腰椎融合术后融合率逐渐提高^[1],但术后邻近节段病变(adjacent segment disease, ASDis)的发生严重影响了腰椎融合的手术效果,通常需要二次手术治疗^[2],既增加了医疗成本,也降低了患者手术满意度。研究发现,术前患者脊柱-骨盆矢状位整体失衡或术后腰椎前凸角(lumbar lordosis, LL)恢复不良是融合术后发生 ASDis 的危险因素^[3]。术后理想 LL 与骨盆入射角(pelvic incidence, PI)有关,理想 LL 应在 $PI \pm 9^\circ$ 范围内,LL 超出此范围则与不良临床表现明显相关^[4]。本研究通过对近 5 年我院收治的因 ASDis 行翻修手术的患者矢状位参数进行分析,进一步确认腰椎融合术后 ASDis 与矢状位参数的相关性,并探讨其在预防 ASDis 中的临床应用。

1 对象和方法

1.1 研究对象 选取我院 2013 年 1 月至 2017 年 10 月因腰椎融合术后 ASDis 行腰椎翻修手术的患者作为 ASDis 组,同时按照年龄、性别配对原则按 1:2 的比例选取行腰椎融合术后在相同随访期内未发生 ASDis 的患者作为对照组。ASDis 组纳入标准:(1)初次手术病因为腰椎退变性疾病;(2)初次手术节段为 $L_4 \sim S_1$;(3)翻修原因为 ASDis,即经历 6 个月以上症状缓解期后又出现与手术邻近节段影像学表现一致的症状和(或)体征。对照组纳入标准:(1)初次手术病因为腰椎退变性疾病;(2)初次手术节段为 $L_4 \sim S_1$;(3)随访期内未发生 ASDis。两组共同的排除标准:(1)合并退变性腰椎侧凸、肿瘤、感染或骨折等疾病;(2)初次手术后椎间不融合。

1.2 数据获取 统计 ASDis 组及对照组患者的一般资料,包括初次手术时的年龄、性别、体质量

指数(body mass index, BMI)、手术原因及随访时间(ASDis 组随访时间定义为初次手术至翻修手术前末次检查的时间,即两次手术间隔时间)。通过我院影像归档和通信系统(picture archiving and communication system, PACS)在末次随访时的全脊柱正侧位 X 线片上,获取 ASDis 组和对照组患者的主要脊柱-骨盆矢状位参数,包括胸椎后凸角(thoracic kyphosis, TK)、矢状位躯干偏移(sagittal vertical axis, SVA)、LL、手术节段腰椎前凸角(segmental lumbar lordosis, sLL)、PI、骨盆倾斜角(pelvic tilt, PT)、骶骨倾斜角(sacral slope, SS)。根据文献[4-5]报道的方法,进一步计算 PI 与 LL 的匹配情况(以 PI 与 LL 的差值表示, $PI-LL$)及 sLL 与 LL 的比值(RL),并分别统计两组病例中 $SVA > 50\text{ mm}$ 、 $RL > 60\%$ 及 PI 和 LL 不匹配的人数。

1.3 统计学处理 采用 SPSS 19.0 软件进行统计学分析。计量资料以 $\bar{x} \pm s$ 表示,两组间比较采用独立样本 t 检验;计数资料以例数和百分数表示,两组间比较采用 χ^2 检验。通过交叉表检验计算相对危险度。检验水准(α)为 0.05。

2 结果

2.1 两组患者一般资料的比较 ASDis 组患者 25 例,男 11 例、女 14 例,年龄为 (55.8 ± 11.9) 岁, BMI 为 $(26.9 \pm 3.6) \text{ kg/m}^2$,初次手术病因包括腰椎管狭窄症 8 例、腰椎间盘突出症 17 例,随访时间(两次手术间隔时间)为 (79.6 ± 45.7) 个月;对照组患者 50 例,男 24 例、女 26 例,年龄为 (55.2 ± 13.0) 岁, BMI 为 $(26.0 \pm 3.0) \text{ kg/m}^2$,初次手术病因包括腰椎管狭窄症 18 例、腰椎间盘突出症 32 例,随访时间为 (78.8 ± 44.7) 个月。两组患者年龄、性别、BMI、随访时间及初次手术病因差异均无统计学意义(P 均 > 0.05),具有可比性。见表 1。

表 1 ASDis 组和对照组患者一般资料

Tab 1 General data of patients in ASDis and control groups

Index	ASDis group <i>N</i> =25	Control group <i>N</i> =50	Statistic	<i>P</i> value
Age (year), $\bar{x} \pm s$ (range)	55.8 $\pm$ 11.9 (28-76)	55.2 $\pm$ 13.0 (32-82)	<i>t</i> =0.19	0.84
Gender <i>n</i> (%)			χ^2 =0.11	0.74
Male	11 (44.0)	24 (48.0)		
Female	14 (56.0)	26 (52.0)		
Body mass index (kg $\cdot$ m ⁻²), $\bar{x} \pm s$ (range)	26.9 $\pm$ 3.6 (21.6-37.1)	26.0 $\pm$ 3.0 (19.2-31.4)	<i>t</i> =1.14	0.25
Follow-up <i>t</i> /month, $\bar{x} \pm s$ (range)	79.6 $\pm$ 45.7 (12-168)	78.8 $\pm$ 44.7 (12-160)	<i>t</i> =0.07	0.94
Cause of primary operation <i>n</i> (%)			χ^2 =0.12	0.73
Lumbar spinal stenosis	8 (32.0)	18 (36.0)		
Lumbar disc herniation	17 (68.0)	32 (64.0)		

ADSiS: Adjacent segment disease

2.2 两组患者矢状位参数的比较 对 ASDis 组翻修手术前末次检查和对照组患者末次随访时的矢状位参数进行分析, 结果 (表 2) 显示 ASDis 组 LL、sLL、SS 均小于对照组, PT 大于对照组, 差异均有统计学意义 (*P* 均 < 0.05); 两组患者之间 TK 和 PI 差异均无统计学意义 (*P* 均 >

0.05); ASDis 组中 SVA > 50 mm 的患者比例、PI-LL $\geq 10^\circ$ 的患者比例、RL < 60% 的患者比例均高于对照组, 差异均有统计学意义 (*P* 均 < 0.05)。通过计算相对危险度发现, RL < 60% 是 ASDis 发生的危险因素 (相对危险度为 10.19, 95% 置信区间为 3.01~34.48)。

表 2 末次随访时 ASDis 组和对照组矢状位参数的比较

Tab 2 Comparison of sagittal parameters between ASDis and control groups at the last follow-up

Index	ASDis group <i>N</i> =25	Control group <i>N</i> =50	Statistic	<i>P</i> value
TK θ ($^\circ$), $\bar{x} \pm s$	29.64 $\pm$ 4.81	29.02 $\pm$ 7.22	<i>t</i> =0.44	0.66
LL θ ($^\circ$), $\bar{x} \pm s$	36.00 $\pm$ 5.44	43.88 $\pm$ 10.62	<i>t</i> =-4.25	<0.01
sLL θ ($^\circ$), $\bar{x} \pm s$	17.80 $\pm$ 5.79	27.62 $\pm$ 6.74	<i>t</i> =-5.07	<0.01
PI θ ($^\circ$), $\bar{x} \pm s$	53.62 $\pm$ 7.61	49.82 $\pm$ 9.27	<i>t</i> =1.77	0.08
SS θ ($^\circ$), $\bar{x} \pm s$	27.50 $\pm$ 5.30	31.06 $\pm$ 7.48	<i>t</i> =-2.13	0.04
PT θ ($^\circ$), $\bar{x} \pm s$	26.12 $\pm$ 8.24	18.80 $\pm$ 7.67	<i>t</i> =3.80	<0.01
SVA > 50 mm <i>n</i> (%)	16 (64.0)	11 (22.0)	χ^2 =12.76	<0.01
PI-LL $\geq 10^\circ$ <i>n</i> (%)	18 (72.0)	21 (42.0)	χ^2 =6.01	0.01
RL < 60% <i>n</i> (%)	21 (84.0)	17 (34.0)	χ^2 =16.67	<0.01

ADSiS: Adjacent segment disease; TK: Thoracic kyphosis; LL: Lumbar lordosis; sLL: Segmental lumbar lordosis; PI: Pelvic incidence; SS: Sacral slope; PT: Pelvic tilt; SVA: Sagittal vertical axis; RL: Ratio of SLL to LL

3 讨论

随着人口老龄化发展, 腰椎退变性疾病患者增多, 腰椎融合手术也越来越常见, 但术后 ASDis 严重影响手术效果, 常需二次手术治疗。据报道, 腰椎融合术后 ASDis 的发生率为 5.2%~16.5%, 且以 3.9% 的速度逐年增加, 病变好发于头侧邻近节段^[6-8]。

腰椎融合术后发生 ASDis 的危险因素主要包括患者个体因素及手术操作因素 2 个方面。研究表明, 高龄及肥胖是腰椎融合术后发生 ASDis 的危险因素^[9-10], 术前存在手术节段邻近节段椎间盘退变会增加融合术后 ASDis 的发生率^[11]。Ramirez-Villaescusa 等^[12]通过对因 ASDis 行翻修手术的病例

进行分析显示, 当初次手术病因为腰椎管狭窄且固定节段在 3 个以上时, 发生融合术后 ASDis 的概率明显提高。近年来, 较多研究关注了脊柱-骨盆矢状位平衡与 ASDis 的关系。有研究指出, 术前腰椎前凸降低是发生 ASDis 的危险因素^[12-13], 而 Umehara 等^[14]发现术后脊柱-骨盆矢状位整体失衡 (SVA > 50 mm) 的患者发生 ASDis 的比例明显增高, 认为这是由矢状位失衡导致手术近端节段应力分布异常引起的。Matsumoto 等^[13]进一步指出, 手术前后 LL 降低和 PI-LL $\geq 10^\circ$ 是 ASDis 发生的危险因素, 并强调手术恢复正常腰椎前凸在减少 ASDis 发生中具有重要意义。这与本研究结果一致。

有研究发现, L₄~S₁ 段发生的下腰椎前凸构成 LL 的主要部分, 恢复 LL 主要在于恢复下腰

椎 LL^[15]。本研究发现, L₄~S₁ 节段腰椎融合术后发生 ASDis 的患者 sLL 小于未发生 ASDis 的患者 ($P<0.01$), 且 RL (sLL 占 LL 的比例) $<60\%$ 的患者比例高于对照组 ($P<0.01$), 表明 sLL 与术后 ASDis 的发生关系密切。这可能是由于手术节段前凸恢复不良导致腰椎近端节段代偿性后凸, 进而引起近端邻近节段的退变, 同时也可能是 ASDis 好发于手术节段近端邻近节段的原因之一。

在临床实践中, 下腰椎手术后因发生上方 ASDis 行翻修手术的患者并不少见。本研究结果表明, 下腰椎手术时行椎间隙撑开恢复椎间隙高度及手术节段 LL, 进而减少近端节段的代偿性后凸, 可能有助于预防术后 ASDis 的发生。但本研究样本量小, 且未分析两组患者初次手术之前的矢状位参数, 无法确定矢状位失衡与术后 ASDis 发生的因果关系, 今后需进一步增加样本量并注意留存患者的影像学资料以开展长时间随访研究, 从而获得更可靠的结果, 并更好地指导临床实践。

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