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• 专题报道 •

## 伴左肩低的 Lenke 2A 型青少年特发性脊柱侧凸：过度融合上胸弯会增加远端叠加的风险

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**[摘要]** **目的** 评估伴左肩低的 Lenke 2A 型青少年特发性脊柱侧凸 (AIS) 患者上胸弯融合与术后远端叠加现象的相关性。**方法** 回顾性分析 2010 年 7 月 16 日至 2018 年 10 月 21 日于我院行脊柱后路胸腰椎融合术的 104 例术前左肩低的 Lenke 2A 型 AIS 患者资料, 所有患者均获得至少 2 年的随访, 并通过 X 线片测量影像学参数。根据手术上端固定椎 (UIV) 的选择将患者分为  $\geq T_3$  组 (UIV 在  $T_3$  及  $T_3$  以上) 和  $< T_3$  组 (UIV 在  $T_3$  以下), 比较两组术前、术后及末次随访时的影像学参数、远端叠加发生率及生活质量 (脊柱侧凸研究协会 22 项问卷评分)。**结果** 104 例患者平均年龄为 (14.8 $\pm$ 3.2) 岁, 平均随访时间为 (33.0 $\pm$ 9.6) 个月。 $\geq T_3$  组 71 例,  $< T_3$  组 33 例, 两组术前临床及影像学参数匹配 ( $P>0.05$ )。末次随访时, 27 例 (26.0%) 患者发生远端叠加,  $\geq T_3$  组远端叠加的发生率高于  $< T_3$  组 [31.0% (22/71) vs 15.2% (5/33),  $P<0.001$ ]; 15 例 (14.4%) 患者发生术后肩部不平衡 (PSI), 其中  $\geq T_3$  组 11 例 (15.5%),  $< T_3$  组 4 例 (12.1%); 两组患者生活质量评分差异无统计学意义 ( $P>0.05$ )。多因素 logistic 回归分析显示, Risser 分级和 UIV 选择是伴左肩低 Lenke 2A 型 AIS 患者术后发生远端叠加的独立影响因素 (均  $P<0.05$ )。**结论** 对于伴左肩低的 Lenke 2A 型 AIS 患者, UIV 的选择与术后远端叠加发生率有关, 融合上胸弯或将导致远端叠加风险增加。

**[关键词]** 青少年特发性脊柱侧凸; 脊柱后路胸腰椎融合术; 远端叠加; 上端固定椎; 上胸弯

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### Lenke type 2A adolescent idiopathic scoliosis with low left shoulder: excessive fusion of proximal thoracic curve increases the risk of distal adding-on

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**[Abstract]** **Objective** To evaluate the correlation between proximal thoracic curve fusion and postoperative distal adding-on in Lenke type 2A adolescent idiopathic scoliosis (AIS) patients with low left shoulder. **Methods** The data of 104 patients with Lenke type 2A AIS with low left shoulder who underwent posterior thoracolumbar fusion in our hospital were retrospectively analyzed. All patients were followed up for at least 2 years, and the imaging parameters were measured by X-ray. The patients were divided into  $\geq T_3$  group (upper instrumented vertebra [UIV] at  $T_3$  or above  $T_3$ ) and  $< T_3$  group (UIV below  $T_3$ ) according to the choice of UIV. The imaging parameters, the incidence of distal adding-on and the quality of life (scoliosis research society-22 questionnaire score) were compared between the 2 groups before and after operation and at the last follow-up. **Results** The average age of the 104 patients was (14.8 $\pm$ 3.2) years old, and the average follow-up time was (33.0 $\pm$ 9.6) months. There were 71 cases in  $\geq T_3$  group and 33 cases in  $< T_3$  group. The preoperative clinical and imaging parameters of the 2 groups were matched ( $P>0.05$ ). At the last follow-up, 27 (26.0%) patients had distal adding-on, and its incidence in  $\geq T_3$  group was significantly higher than that in  $< T_3$  group (31.0% [22/71] vs 15.2% [5/33],  $P<0.001$ ). Postoperative shoulder imbalance (PSI) occurred in 15 (14.4%) patients, including 4 (12.1%) patients in  $< T_3$  group and 11 (15.5%) patients in  $\geq T_3$  group. There was no significant difference in quality of life scores between the 2 groups ( $P>0.05$ ). Multivariate logistic regression analysis showed that Risser grade and UIV selection were independent influencing factors for postoperative distal adding-on in Lenke type 2A AIS patients with low left shoulder (both  $P<0.05$ ). **Conclusion** For patients with Lenke type 2A AIS and lower left shoulder, the choice of UIV is related to the incidence of distal adding-on after operation. For such patients, the fusion of the proximal thoracic curve may increase the risk of distal adding-on.

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[ Key words ] adolescent idiopathic scoliosis; posterior thoracolumbar fusion; adding-on; upper instrumented vertebra; proximal thoracic curve

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青少年特发性脊柱侧凸 (adolescent idiopathic scoliosis, AIS) 是一种脊柱三维畸形<sup>[1]</sup>。Lenke 2A 型 AIS 包括结构性的主胸弯和上胸弯<sup>[2-4]</sup>, 对于度数较大的 Lenke 2A 型侧弯, 通常采用后路胸椎融合术进行矫治, 其目的是在矫正畸形的同时尽可能保留腰椎活动节段<sup>[5-6]</sup>。然而, 这种方法存在远端叠加现象 (distal adding-on) 等并发症风险。远端叠加的特征是远端固定椎 (lowest instrumented vertebra, LIV) 逐渐偏移中线或 LIV 下位椎间盘成角逐渐增大, 包括远端融合椎下位椎间盘成角增加  $>5^\circ$ 、LIV 下位椎体偏移骶骨中垂线 (central sacral vertical line, CSVL) 的距离增加  $>5\text{ mm}$ 。远端叠加可能加速 LIV 下方椎间盘的退变, 引起外观畸形加重、疼痛不适等, 降低患者满意度<sup>[7-9]</sup>。因此, 如何降低术后叠加发生率一直是学者研究的热点。

在以往的研究中, 关于 Lenke 2A 型 AIS 中远端叠加危险因素的研究集中在 LIV 的选择上, LIV 位置过高 (LIV 位于远端充分触及椎体近端)、LIV 旋转或偏移中线过大等诸多因素都会增加术后远端叠加的风险<sup>[10-12]</sup>。上端固定椎 (upper instrumented vertebra, UIV) 的选择在 Lenke 2A 型 AIS 中一直是研究的热点, 其选择存在一定的争议, 一般认为对于右胸弯患者, 如果术前左肩较高, 则应融合上胸弯; 而对于术前左肩低的患者, 上胸弯是否融合存在不确定性<sup>[13-14]</sup>。既往关于 UIV 的选择主要集中在其与肩平衡的关系上<sup>[15-16]</sup>, 而 Cao 等<sup>[17]</sup>和 Qin 等<sup>[18]</sup>研究发现肩平衡与远端叠加存在一定的相互代偿关系。因此, 本研究针对术前左肩低的 Lenke 2A 型患者, 分析上胸弯的融合是否会增加远端叠加的发生风险。

## 1 资料和方法

1.1 病例资料 回顾性选择 2010 年 7 月 16 日至 2018 年 10 月 21 日在我院行脊柱后路胸腰椎融合手术且仅使用椎弓根螺钉内固定的 AIS 患者为研究对象。纳入标准: Lenke 2A 型右胸弯; 年龄为

11~18 岁; 术前左肩低于右肩; 术后随访 2 年以上; 有完整的临床和影像学资料。排除标准: 神经性肌源性及先天性脊柱侧凸; 神经系统查体异常; 有其他脊柱手术史。LIV 的选择由经验丰富的脊柱外科医师根据远端充分触及椎 (last substantially touched vertebra, LSTV) 原则<sup>[19-20]</sup>确定。UIV 的选择同样由经验丰富的脊柱外科医师根据术前双肩平衡等的相关策略决定。根据 UIV 的选择, 将患者分为  $\geq T_3$  组 (UIV 在  $T_3$  及  $T_3$  以上) 和  $< T_3$  组 (UIV 在  $T_3$  以下)。记录患者年龄、性别及 Risser 分级等临床信息。

1.2 影像学数据测量 收集术前、术后及末次随访时患者直立后前位和侧位 X 线片测量结果, 并评估术前左右弯曲位 (bending 位) X 线片数据。测量的影像学参数包括上胸弯、主胸弯和腰弯的 Cobb 角, 主胸弯的顶椎偏移, LIV 相对于 CSVL 的位置, 融合节段下方第 1 个椎间盘的倾斜程度, 冠状面和矢状面平衡, 躯干移位, 以及锁骨角、 $T_1$  倾斜角和 X 线片肩部高度 (radiographical shoulder height, RSH)。术后肩部不平衡 (postoperative shoulder imbalance, PSI) 定义为术后左肩抬高  $2\text{ cm}$ <sup>[21]</sup>。冠状面  $C_7$  铅垂线与 CSVL 的偏差用于测量冠状面平衡, 其值  $>20\text{ mm}$  表示冠状面失衡。 $C_7$  铅垂线偏离骶骨后缘 (也称为矢状面垂直轴, sagittal vertical axis, SVA) 用于测量矢状面平衡, 其值  $>50\text{ mm}$  表示矢状面失衡<sup>[22]</sup>。在躯干垂直参考线和 CSVL 之间测量躯干移位<sup>[21]</sup>。侧弯柔韧性 (%) = (术前站立位 Cobb 角 - 术前弯曲位 Cobb 角) / 术前站立位 Cobb 角  $\times 100\%$ <sup>[21]</sup>。矫正率 (%) = (术前 Cobb 角 - 术后 Cobb 角) / 术前 Cobb 角  $\times 100\%$ <sup>[22]</sup>。当融合节段下方第 1 个椎体与 CSVL 之间的距离增加  $>5\text{ mm}$  或融合节段下方第 1 个椎间盘的角度增加  $>5^\circ$  时, 被认为是发生了远端叠加<sup>[23]</sup>。

所有测量均由两人使用 Surgimap 2.1.2 软件共同完成。此外, 随机选择 20 例患者用于评估测量值的观察者内和观察者间变异性。所有参数具有较强的观察者内和观察者间一致性, Kappa 系数均在 0.8 以上。

1.3 生活质量评估 在末次随访时, 患者填写脊柱

侧凸研究协会 22 项 (scoliosis research society-22, SRS-22) 问卷<sup>[24]</sup>。该问卷涵盖功能/活动、疼痛、自我感知形象、治疗满意度和心理健康 5 个维度。每个维度包含 5 个问题选项,分值为 1~5,5 分代表理想的回答。5 个维度得分的平均值为问卷结果。

1.4 统计学处理 采用 SPSS 20.0 软件对数据进行分析。计量资料以  $\bar{x} \pm s$  表示,采用方差分析、*t* 检验进行比较。计数资料以例数和百分数表示,采用  $\chi^2$  检验进行比较。通过逐步 logistic 回归分析考察远端叠加的影响因素。检验水准 ( $\alpha$ ) 为 0.05。

## 2 结果

### 2.1 患者手术前后影像学资料 共 104 例术前左肩

低的 Lenke 2A 型 AIS 患者纳入研究,其中女 73 例、男 31 例,手术时年龄为 (14.8±3.2) 岁,随访时间为 24~74 (33.0±9.6) 个月,Risser 分级为 3.3±1.5。患者影像学资料见表 1。术前上胸弯、主胸弯和腰弯的平均 Cobb 角分别为 (41.0±9.0)°、(55.6±11.8)°和 (25.7±7.6)°,侧弯柔韧性分别为 (22.9±14.0)%、(42.9±17.3)% 和 (71.3±36.2)%。末次随访时,上胸弯、主胸弯和腰弯的平均 Cobb 角分别为 (22.5±7.5)°、(20.4±7.7)°、(9.2±5.1)°,矫正率分别为 (42.5±20.6)%、(62.8±13.4)% 和 (62.1±21.5)%。冠状面失衡 5 例,矢状面失衡 6 例。末次随访时,27 例 (26.0%) 患者出现远端叠加,无患者因叠加现象进行翻修手术。

表 1 伴左肩低 Lenke 2A 型 AIS 患者手术前后的影像学资料

Tab 1 Preoperative and postoperative radiographical data of Lenke type 2A AIS patients with low left shoulder

Index	Preoperative	Immediately postoperative	Final follow-up
Proximal thoracic curve/(°)	41.0±9.0	21.0±6.3	22.5±7.5
Flexibility of proximal thoracic curve/%	22.9±14.0		
Main thoracic curve/(°)	55.6±11.8	19.4±6.5	20.4±7.7
Flexibility of main thoracic curve/%	42.9±17.3		
Lumbar curve/(°)	25.7±7.6	7.2±4.5	9.2±5.1
Flexibility of lumbar curve/%	71.3±36.2		
Thoracic kyphosis/(°)	16.6±9.4	14.4±8.2	15.2±7.6
Lumbar lordosis/(°)	47.6±15.9	44.6±12.3	45.4±9.6
Coronal balance/mm	13.6±8.4	12.3±9.2	10.5±8.9
Sagittal balance/mm	-13.5±29.4	-8.5±31.3	-8.8±29.6
Apical vertebra translation/mm	49.1±17.2	13.4±12.2	12.8±10.1
T <sub>1</sub> tilt angle/(°)	6.5±6.7	8.9±3.9	8.6±5.8
Clavicle angle/(°)	-2.5±1.8	2.3±2.9	1.6±1.9
RSH/mm	-9.0±6.5	9.1±11.1	6.1±7.5
Trunk shift/mm	8.8±12.1	-0.6±11.3	-2.3±10.5

AIS: Adolescent idiopathic scoliosis; RSH: Radiographical shoulder height.

2.2 UIV 选择 ≥T<sub>3</sub> 组与 <T<sub>3</sub> 组患者临床及影像学参数比较 根据 UIV 的选择, ≥T<sub>3</sub> 组患者 71 例 (图 1, 表 2), <T<sub>3</sub> 组患者 33 例 (图 2, 表 2)。两组患者术前临床及影像学参数匹配 (均 *P*>0.05)。LIV 的选择采用 LSTV 原则,且在两组间差异无统计学意义 (*P*>0.05)。两组患者术后即刻的 RSH、躯干平衡及上胸弯、主胸弯残留角度差异均无统计学意义 (均 *P*>0.05)。末次随访时, ≥T<sub>3</sub> 组的远端叠加发生率高于 <T<sub>3</sub> 组 (*P*<0.001); 两组在锁骨角、RSH 和躯干移位等方面差异均无统计学意义 (均 *P*>0.05); 15 例 (14.4%) 患者发生 PSI, 其中 <T<sub>3</sub> 组 4 例 (12.1%), ≥T<sub>3</sub> 组 11 例 (15.5%), 差异无统计学意义 (*P*>0.05)。

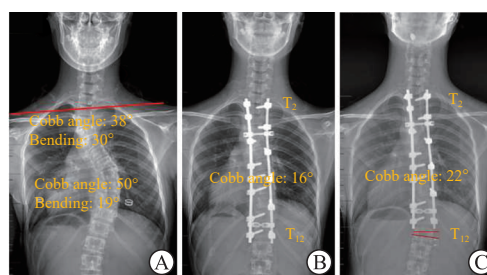


图 1 UIV 高于 T<sub>3</sub> 患者的影像学资料

Fig 1 Radiographical data of patients with UIV above T<sub>3</sub>. A 16-year-old girl with Lenke type 2A AIS. A: Preoperative X-ray showed low left shoulder (RSH was 11.7 mm, red line); B: Immediately postoperative, UIV was T<sub>2</sub>; C: After 2 years of follow-up, the shoulder balance was improved, and X-ray showed adding-on (red lines). UIV: Upper instrumented vertebra; AIS: Adolescent idiopathic scoliosis; RSH: Radiographical shoulder height.

表2 UIV选择 $\geq T_3$ 组和 $< T_3$ 组伴左肩低 Lenke 2A型AIS患者的临床和影像学资料

Tab 2 Clinical and radiographical data of Lenke type 2A AIS patients with low left shoulder in UIV $\geq T_3$  and  $< T_3$  groups

Index	$\geq T_3$ group N=71	$< T_3$ group N=33	P value
Gender, n (%)			0.214
Female	48 (67.6)	25 (75.8)	
Male	23 (32.4)	8 (24.2)	
Age/year, $\bar{x} \pm s$	15.1 $\pm$ 3.3	14.1 $\pm$ 2.8	0.869
Follow up duration/month, $\bar{x} \pm s$	33.9 $\pm$ 10.4	31.1 $\pm$ 7.3	0.231
Risser grade, $\bar{x} \pm s$	3.6 $\pm$ 1.5	3.4 $\pm$ 1.6	0.492
LIV, n (%)			0.352
T <sub>12</sub>	12 (16.9)	7 (21.2)	
L <sub>1</sub>	34 (47.9)	14 (42.4)	
L <sub>2</sub>	25 (35.2)	12 (36.4)	
Preoperative radiographical data, $\bar{x} \pm s$			
Proximal thoracic curve/(°)	42.7 $\pm$ 8.8	40.7 $\pm$ 6.3	0.250
Flexibility of proximal thoracic curve/%	24.9 $\pm$ 14.9	17.9 $\pm$ 9.5	0.227
Main thoracic curve/(°)	54.8 $\pm$ 10.9	57.3 $\pm$ 13.4	0.545
Flexibility of main thoracic curve/%	43.6 $\pm$ 17.4	41.2 $\pm$ 17.1	0.829
Lumbar curve/(°)	24.1 $\pm$ 7.6	29.1 $\pm$ 6.6	0.179
Flexibility of lumbar curve/%	70.0 $\pm$ 33.4	74.1 $\pm$ 42.2	0.222
Thoracic kyphosis/(°)	18.0 $\pm$ 10.1	13.7 $\pm$ 7.4	0.092
Lumbar lordosis/(°)	47.8 $\pm$ 12.7	47.1 $\pm$ 21.6	0.232
Coronal balance/mm	0.9 $\pm$ 13.6	8.7 $\pm$ 18.2	0.081
Sagittal balance/mm	-9.9 $\pm$ 29.5	-21.1 $\pm$ 28.3	0.788
Apical vertebra translation/mm	45.6 $\pm$ 14.5	57.6 $\pm$ 19.7	0.204
T <sub>1</sub> tilt angle/(°)	7.2 $\pm$ 7.0	6.9 $\pm$ 5.8	0.851
Clavicle angle/(°)	-2.3 $\pm$ 1.8	-2.9 $\pm$ 1.9	0.178
RSH/mm	-8.2 $\pm$ 6.3	-10.7 $\pm$ 6.6	0.265
Trunk shift/mm	18.0 $\pm$ 10.1	13.7 $\pm$ 7.4	0.029
Immediately postoperative radiographical data, $\bar{x} \pm s$			
Proximal thoracic curve/(°)	23.1 $\pm$ 4.6	20.1 $\pm$ 5.8	0.201
Main thoracic curve/(°)	18.8 $\pm$ 6.7	20.8 $\pm$ 5.7	0.641
Lumbar curve/(°)	6.7 $\pm$ 3.6	7.4 $\pm$ 4.9	0.378
T <sub>1</sub> tilt angle/(°)	8.3 $\pm$ 4.2	8.8 $\pm$ 4.6	0.738
Clavicle angle/(°)	-2.3 $\pm$ 3.0	-2.5 $\pm$ 2.9	0.804
RSH/mm	-9.2 $\pm$ 11.1	-8.3 $\pm$ 11.3	0.747
Coronal balance/mm	12.7 $\pm$ 9.6	11.8 $\pm$ 12.1	0.213
Sagittal balance/mm	-6.4 $\pm$ 30.7	-5.0 $\pm$ 31.7	0.816
Final follow-up radiographical data			
Proximal thoracic curve/(°), $\bar{x} \pm s$	21.7 $\pm$ 8.8	23.1 $\pm$ 7.6	0.105
Main thoracic curve/(°), $\bar{x} \pm s$	19.6 $\pm$ 7.7	22.1 $\pm$ 7.6	0.799
Lumbar curve/(°), $\bar{x} \pm s$	9.3 $\pm$ 5.3	8.9 $\pm$ 4.8	0.179
Thoracic kyphosis/(°), $\bar{x} \pm s$	15.5 $\pm$ 6.8	14.2 $\pm$ 8.2	0.308
Lumbar lordosis/(°), $\bar{x} \pm s$	44.7 $\pm$ 9.4	44.3 $\pm$ 9.3	0.799
Coronal balance/mm, $\bar{x} \pm s$	10.7 $\pm$ 9.5	10.6 $\pm$ 8.1	0.328
Sagittal balance/mm, $\bar{x} \pm s$	-6.1 $\pm$ 31.7	-16.9 $\pm$ 38.3	0.204
Apical vertebra translation/mm, $\bar{x} \pm s$	12.7 $\pm$ 9.3	11.1 $\pm$ 9.8	0.923
T <sub>1</sub> tilt angle/(°), $\bar{x} \pm s$	8.4 $\pm$ 4.2	8.8 $\pm$ 4.7	0.590
Clavicle angle/(°), $\bar{x} \pm s$	1.8 $\pm$ 2.0	1.2 $\pm$ 1.6	0.130
RSH/mm, $\bar{x} \pm s$	6.9 $\pm$ 8.1	4.5 $\pm$ 5.6	0.074
Trunk shift/mm, $\bar{x} \pm s$	-1.4 $\pm$ 11.3	-0.3 $\pm$ 11.0	0.986
PSI, n (%)	11 (15.5)	4 (12.1)	0.540
Adding-on, n (%)	22 (31.0)	5 (15.2)	<0.001

UIV: Upper instrumented vertebra; AIS: Adolescent idiopathic scoliosis; LIV: Lowest instrumented vertebra; RSH: Radiographical shoulder height; PSI: Postoperative shoulder imbalance.

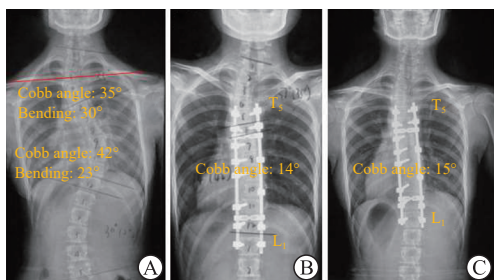


图2 UIV 低于 T<sub>3</sub> 患者的影像学资料

**Fig 2 Radiographical data of patients with UIV below T<sub>3</sub>**  
 A 17-year-old girl with Lenke type 2A AIS. A: Preoperative X-ray showed low left shoulder (RSH was 12.3 mm, red line); B: Immediately postoperative, UIV was T<sub>5</sub>; C: After 2 years of follow-up, X-ray showed no adding-on. UIV: Upper instrumented vertebra; AIS: Adolescent idiopathic scoliosis; RSH: Radiographical shoulder height.

2.3 UIV 选择 ≥T<sub>3</sub> 组与 <T<sub>3</sub> 组患者生活质量比较 末次随访时, 两组患者 SRS-22 问卷各维度评分差异均无统计学意义 (均 P>0.05)。见表 3。

表3 UIV 选择 ≥T<sub>3</sub> 组和 <T<sub>3</sub> 组伴左肩低 Lenke 2A 型 AIS 患者的 SRS-22 问卷评分比较

Tab 3 Comparison of SRS-22 questionnaire scores between UIV ≥T<sub>3</sub> group and <T<sub>3</sub> group of patients with Lenke type 2A AIS and low left shoulder

Event	≥T <sub>3</sub> group n=71	<T <sub>3</sub> group n=33	$\bar{x} \pm s$ P value
Function	4.4 ± 0.5	4.4 ± 0.6	0.653
Pain	4.5 ± 0.4	4.6 ± 0.5	0.457
Self-image	4.3 ± 0.5	4.4 ± 0.5	0.570
Mental health	4.3 ± 0.6	4.4 ± 0.7	0.304
Satisfaction	4.5 ± 0.4	4.4 ± 0.5	0.807

UIV: Upper instrumented vertebra; AIS: Adolescent idiopathic scoliosis; SRS-22: Scoliosis research society-22.

2.4 远端叠加的影响因素分析 多因素二项 logistic 回归分析显示, Risser 分级和 UIV 选择是伴左肩低 Lenke 2A 型 AIS 患者术后发生远端叠加的独立影响因素。见表 4。

表4 伴左肩低 Lenke 2A 型 AIS 患者术后远端叠加影响因素的 logistic 回归分析

Tab 4 Logistic regression analysis of influencing factors of distal adding-on in Lenke type 2A AIS patients with low left shoulder

Variable	R <sup>2</sup>	P value	OR
Choice of UIV	1.785	0.038	5.962
Risser grade	-0.612	0.007	0.543
Apical vertebra translation	-0.031	0.102	0.970
Coronal balance	0.037	0.080	1.037
T <sub>1</sub> tilt angle	-0.054	0.172	0.947

AIS: Adolescent idiopathic scoliosis; UIV: Upper instrumented vertebra; R<sup>2</sup>: Coefficient of determination; OR: Odds ratio.

### 3 讨论

Lenke 分型最早由 Lenke 等<sup>[4]</sup>于 2001 年提出, 该分类考虑了脊柱侧凸的位置、柔韧性和弯曲严重程度, 用于指导治疗和比较不同治疗方法的优劣<sup>[2]</sup>。经过多年的发展, Lenke 分型已成为国际公认的指导手术方案和预后的重要标准。虽然它的分类系统有助于指导不同分型的手术方案, 但它并没有明确定义融合的具体节段。减少融合节段可以降低手术成本、提高患者术后生活质量。

关于 Lenke 2A 型 AIS 患者远端叠加的研究倾向关注 LIV 的选择<sup>[8,11-12]</sup>。而针对于 UIV 的选择研究较少。Suk 等<sup>[6]</sup>认为当上胸弯 Cobb 角 >25°、左肩高于右肩超过 10 mm 的患者上胸弯应该融合。而当上胸弯 Cobb 角为 25°~40°时, 若右肩高于左肩, 特别是当双肩高度差 >12 mm 时上胸弯不需要融合<sup>[25]</sup>。Jiang 等<sup>[13]</sup>认为, 除了根据 Lenke 分型考虑术前双肩高度差外, 在选择 UIV 时还应综合考虑上胸弯的柔韧性、主胸弯的大小等因素, 对于术前上胸弯柔韧性好、右肩高的患者, UIV 可选择 T<sub>4</sub> 或 T<sub>5</sub>; 对于上胸弯僵直且术前左肩高或肩平的患者, UIV 应为 T<sub>1</sub> 或 T<sub>2</sub>; 对于上胸弯僵直且术前右肩较高的患者, 上胸弯也可以部分融合或不融合, 无需过度矫正。Kuklo 等<sup>[15]</sup>也报道, 如果患者术前肩部平衡, 上胸弯是否融合对术后肩部平衡影响不大; 如果术前右肩高, 左肩可以自发抬起以补偿主胸弯的矫正, 即使上胸弯的柔韧性较差也不需要完全融合; 对于术前左肩高的患者, 即使上胸弯柔韧性良好也需要进行上胸弯融合。Menon 等<sup>[16]</sup>根据肩部平衡的决定性因素选择了 UIV, 如果肩部水平取决于上胸弯 (双侧喙突线向上胸凹侧倾斜, 相当于左肩抬高), 无论上胸弯的大小和柔韧性如何, 都建议选择 T<sub>2</sub> 为 UIV; 相反, 如果肩关节水平取决于胸主弯 (双侧喙突线向胸主弯侧倾斜, 相当于右肩抬高), 则建议选择 T<sub>4</sub> 为 UIV, 但应注意避免过度矫正主胸弯<sup>[26]</sup>。这些研究结果反映了目前 UIV 选择的基本状况。尽管在 AIS 患者的双肩平衡中高度重视 UIV 的选择, 但目前尚缺乏对上胸弯 UIV 的选择和术后远端叠加风险的相关性研究。

在本研究中, 26.0% (27/104) 的患者在末次随访时观察到远端叠加现象。以往研究报道, 叠加的发生率为 12.9%~51.1%<sup>[4,6,12-13,27-29]</sup>。本研究

结果与以往报道一致。本研究将 Lenke 2A 型 AIS 患者根据不同的 UIV 选择分为  $\geq T_3$  和  $< T_3$  两组, 分析结果表明  $\geq T_3$  组的叠加风险增加。Cao 等<sup>[17]</sup> 在 142 例患者的研究中发现, 在末次随访时发生远端叠加的患者较少能观察到肩部失平衡, 术后远端叠加很可能与 PSI 之间存在相关性。Zhao 等<sup>[29]</sup> 在 Lenke 1A/B 型 AIS 患者中研究对称胸椎融合时发现, 与对称融合组(在顶椎上下有相同数量的椎体融合)和下优势融合组(顶端以下融合的椎体比顶端以上融合的椎体数多)相比, 上优势融合组(顶端以上融合的椎体比顶端以下融合的椎体数多)远端叠加的发生率显著增加, 这很有可能是因为上胸弯的过度固定会降低通过双肩平衡进行代偿的能力。本研究通过对  $\geq T_3$  和  $< T_3$  两组患者术后即刻的 RSH 及主胸弯残留角度进行对比, 发现并无显著差异, 说明本研究排除手术本身造成的远端叠加危险因素对结果的干扰。因而, 我们认为对术前左肩低的 Lenke 2A 型 AIS 患者进行过度上胸弯固定可能会增加远端叠加的发生风险。

本研究存在以下局限性, 首先, 为回顾性研究设计及缺乏随机化分组; 其次, 结果可能会因相对较少的远端叠加患者而存在偏差。因此, 需要开展更大样本量的研究以进一步得出更加可靠的结论。

综上所述, 对于术前左肩低的 Lenke 2A 型 AIS 患者, UIV 的选择是影响术后远端叠加的重要因素。对于此类患者, 融合上胸弯将导致远端叠加的发生率增加。建议在伴左肩低的 Lenke 2A 型 AIS 患者中谨慎考虑将融合水平延长至  $T_3$  及以上, 以规避因失去肩部平衡的代偿能力而可能导致的远端叠加风险增加。

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