

青少年特发性脊柱侧凸植入物内固定后冠状面失平衡及模型构建

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文章亮点:

以单因素比较和多因素 Logistic 回归分析方法筛选 141 例 Lenke II 型青少年特发性脊柱侧凸患者椎体旋转、Risser 征、主弯矫正率/柔韧性、下胸弯 Cobb 角等因素, 认为这些是其植入物内固定后发生冠状面失平衡的独立危险因素, 并成为构建 Lenke II 型特发性脊柱侧凸畸形的预测模型为 $Y=1/[1+\exp(-1.182X_1+1.228X_2+1.671X_3-0.71X_4+0.407)]$ 。

关键词:

植入物; 脊柱植入物; 数字化骨科; 青少年特发性脊柱侧凸; 失平衡; Lenke II 型; 冠状面; 危险因素; 内固定; 并发症; 融合

主题词:

内固定器; 脊柱侧凸; 回归分析; 线性模型

摘要

背景: 青少年特发性脊柱侧凸是目前临床上影响青少年身体外观的常见病, 但通过 Logistic 回归方程来分析固定后冠状面失平衡目前尚缺乏报道。

目的: 探讨 Lenke II 型青少年特发性脊柱侧凸患者固定后冠状面失平衡的原因。

方法: 对新疆医科大学第一附属医院脊柱外科 2001 年 1 月至 2012 年 11 月收治的 141 例 Lenke II 型青少年特发性脊柱侧凸患者进行多个变量的单因素比较和多因素 Logistic 回归分析, 筛选导致青少年特发性脊柱侧凸患者固定后发生冠状面失平衡的危险因素, 并构建预测模型。

结果与结论: 141 例患者中有 30 例出现固定后冠状面失平衡, 占全部受试患者的 21.28%。对于 Lenke II 型特发性脊柱侧凸患者, 固定前顶椎 3-4 级 Nash-More 椎体旋转、4-5 级 Risser 征、主弯矫正率/柔韧性 >1、下胸弯 Cobb 角 >70° 等易引起固定后冠状面失平衡。多因素 Logistic 回归分析提示椎体旋转、Risser 征、主弯矫正率/柔韧性、下胸弯 Cobb 角等是 Lenke II 型青少年特发性脊柱侧凸患者固定后发生冠状面失平衡的独立危险因素。预测模型为 $Y=1/[1+\exp(-1.182X_1+1.228X_2+1.671X_3-0.71X_4+0.407)]$ 。

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Postoperative coronal plane imbalance and model construction for adolescent idiopathic scoliosis

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Abstract

BACKGROUND: Adolescent idiopathic scoliosis is a common disease that can affect physical appearance of adolescents in the clinic at present. However, there are lacks of studies on coronal plane imbalance after fixation using Logistic regression equation at present.

OBJECTIVE: To investigate the reasons for coronal plane imbalance after fixation in patients with Lenke type II adolescent idiopathic scoliosis.

METHODS: 141 cases of Lenke type II adolescent idiopathic scoliosis admitted by Department of Spinal Surgery of the First Affiliated Hospital of Xinjiang Medical University in China from January 2001 to November 2012 were chosen as subjects. Multivariate single factor and multiple-factor Logistic regression were performed. Risk factors for the coronal plane imbalance after fixation in adolescent idiopathic scoliosis patients were screened, and predictive models were established.

RESULTS AND CONCLUSION: Coronal plane imbalance occurred in 30 of the 141 patients, accounting for 21.28%. For Lenke type II adolescent idiopathic scoliosis patients, preoperative apical vertebral Nash-More rotation level 3-4, Risser grade 4-5, major curve correction rate/flexibility > 1, lower thoracic Cobb angle > 70° were vulnerable to postoperative coronal plane imbalance. Multivariate logistic regression showed that vertebral rotation, Risser grade, major curve correction rate/flexibility, lower thoracic Cobb angle were independent risk factors for postoperative coronal plane imbalance in Lenke type II adolescent idiopathic scoliosis patients. The predictive model was $Y=1/[1+\exp(-1.182X_1+1.228X_2+1.671X_3-0.71X_4+0.407)]$.

Subject headings: internal fixator; scoliosis; regression analysis; linear model

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0 引言 Introduction

青少年特发性脊柱侧凸是在冠状面表现为脊柱侧凸及部分可在矢状面表现为后凸的脊柱三维畸形^[1-9]。与此相关, 脊柱附近相邻解剖结构亦可能随脊柱侧凸的形态及进展的改变而改变^[6-9], 其中, 以冠状面的失衡、双肩及骨盆不等高等表现的最为明显。Li等^[10]研究表明, 产生上述形态学改变的原因很多, 包括机体自身代偿、脊柱附近解剖结构牵拉等。随着手术水平的提高, 越来越多的青少年特发性脊柱侧凸患者通过后路椎弓根螺钉固定及截骨矫形植骨融合内固定治疗^[11-27], 且已有研究证实, 后路椎弓根螺钉系统较哈氏棒及椎板钩系统的矫形力更强, 但固定后冠状面失平衡的发生率仍然保持较高水平^[28-37]。目前对于Lenke II型青少年特发性脊柱侧凸固定后冠状面失平衡的分析很多, 但通过Logistic回归方程来分析固定后冠状面失平衡目前尚缺乏报道。因此作者拟通过卡方检验及Logistic方程方法, 探讨引起青少年特发性脊柱侧凸固定后冠状面失平衡的危险因素。

1 对象和方法 Subjects and methods

设计: 回顾性分析。

时间及地点: 实验于2001年1月至2012年11月在新疆医科大学第一附属医院骨科中心完成。

对象: 回顾性分析新疆医科大学第一附属医院骨科中心自2001年1月至2012年11月收治的Lenke II型青少年特发性脊柱侧凸患者。

诊断标准: 通过详细的体格检查及固定前站立位全脊柱正侧位平片、仰卧位侧方弯曲位平片(Bending像)、全脊柱MRI等明确诊断为Lenke II型青少年特发性脊柱侧凸患者^[1]。

纳入标准: ①符合诊断标准。②年龄11-19岁。③得到患者及家属的知情同意。

排除标准: ①存在脊髓纵裂、脊髓栓系综合征、神经肌源性疾病、结缔组织病、合并脏器畸形等患者。②行支具辅助治疗者。

最终纳入141例患者, 其中男43例, 女98例。

方法:

后路椎弓根螺钉固定或截骨矫形植骨融合内固定方法: 患者使用美国美敦力公司、美国强生公司、美国AO公司、中国威高公司等钛合金椎弓根螺钉及配套连接棒, 采用常规椎弓根螺钉置入方法。

影像学测量: 所有患者均测量身高、体质量, 行固定前后全脊柱正侧位、固定前全脊柱过伸过屈位平片(Bending像)。在全脊柱正位像上测量结构性弯及非结构性弯的Cobb角、固定前双侧锁骨最高点连线与水平线夹角、

固定前双侧骨盆最高点连线与水平线夹角、固定前及固定后冠状面过C₇棘突的铅垂线与骶骨中线的水平距离、冠状面失平衡、Nash-Moe椎体旋转、Risser征、主弯矫正率/柔韧性^[38-47]。具体测量方法如下:

Cobb角: 取脊柱侧凸上端椎的上终板与下端椎的下终板间的夹角。

双侧锁骨最高点连线与水平线夹角: 取双侧锁骨最高点连线与水平线的夹角。

双侧骨盆最高点连线与水平线夹角: 取双侧髂嵴最高点与水平线的夹角。

冠状面过C₇棘突的铅垂线与骶骨中线的水平距离: 冠状面经C₇椎体棘突所做的铅垂线与骶骨中线的水平距离, 铅垂线位于骶骨中线左侧为负值, 位于右侧为正值。

冠状面失平衡定义为固定前及固定后冠状面过C₇棘突的铅垂线与骶骨中线的水平距离的绝对值大于20 mm。

主弯矫正率=(固定前-固定后)Cobb角/固定前Cobb角×100%。

柔韧度(%)=(冠状面主弯Cobb角-凸侧Bending像Cobb角)/冠状面主弯Cobb角×100%。

主要观察指标: 患者固定前后脊柱影像学参数。

统计学分析: 数据采用IBM公司SPSS 19.0软件对数据进行统计学分析。采用卡方检验来比较各组间各数据差异, 将有统计学差异的变量分别赋值并带入Logistic回归方程, 建立Logistic回归模型, 评估各危险因素与青少年特发性脊柱侧凸患者固定后冠状面失平衡的关系。

2 结果 Results

共有141例患者纳入本次实验研究, 最终发生冠状面失平衡的青少年特发性脊柱侧凸患者为30例, 发生率21.3%(表1)。

分别以年龄、性别、民族、身高、椎体旋转、Risser征、上胸弯Cobb角、下胸弯Cobb角、主弯矫正率/柔韧性、固定前双侧锁骨最高点连线与水平线夹角、固定前双侧骨盆最高点连线与水平线夹角、固定前固定前及固定后冠状面过C₇棘突的铅垂线与骶骨中线的水平距离、上下胸弯Cobb角等行卡方检验比较各组间各数据差异, 结果发现患者年龄、民族、身高、双侧锁骨最高点连线与水平线夹角、双侧骨盆最高点连线与水平线夹角、固定前冠状面过C₇棘突的铅垂线与骶骨中线的水平距离、上胸弯Cobb角对固定后是否会出现冠状面失平衡没有影响, 而冠状面失平衡患者椎体旋转、Risser征、主弯矫正率/柔韧性、下胸弯Cobb角与其他患者的差异有显著性意义($P < 0.05$; 表2)。

多因素分析发现青少年特发性脊柱侧凸患者固定后出

表 1 Lenke II 型青少年特发性脊柱侧凸患者临床情况

Table 1 Clinical situations of Lenke type II adolescent idiopathic scoliosis patients

项目	Lenke II 型青少 年特发性脊柱侧凸 患者(n=141)	固定后冠状面 失平衡患者 (n=30)	固定后未出现 冠状面失平衡 患者(n=111)
性别(n, 男/女)	43/98	9/21	34/77
年龄($\bar{x}\pm s$, 岁)	15.11±2.31	14.68±2.21	15.32±1.99
民族(n, 汉族/其他民族)	58/83	12/18	46/65
身高($\bar{x}\pm s$, cm)	153.53±6.25	155.16±4.76	153.17±6.65
体质量($\bar{x}\pm s$, kg)	37.60±7.14	35.17±7.48	38.22±5.49
结构性弯及非结构性 弯的 Cobb 角($\bar{x}\pm s$, °)			
上胸弯	41.2±13.1	40.3±9.8	43.6±12.8
下胸弯	59.4±17.5	59.6±13.2	57.5±18.8
固定前双侧锁骨最高点连线 与水平线夹角($\bar{x}\pm s$, °)	4.3±1.7	4.9±1.4	4.0±1.5
固定前双侧骨盆最高点连线 与水平线夹角($\bar{x}\pm s$, °)	4.4±1.1	4.6±1.1	4.2±0.7
冠状面过 C ₇ 棘突的铅垂 线与骶骨中线的水平距离 ($\bar{x}\pm s$, mm)			
固定前	14.6±4.5	15.1±3.7	14.1±4.9
固定后	13.5±3.4	24.8±4.2	9.7±3.4
Nash-Moe 椎体旋转($\bar{x}\pm s$, 级)	2.9±1.1	3.3±0.6	2.7±1.0
Risser 征($\bar{x}\pm s$, 级)	3.1±1.4	2.7±1.0	3.3±0.8
主弯矫正率/柔韧性($\bar{x}\pm s$)	1.1±0.5	1.4±0.4	0.7±0.4
随访时间($\bar{x}\pm s$, 月)	17.3±9.9	17.3±9.9	17.3±9.9

现冠状面失平衡的影响因素为固定前顶椎Nash-More椎体旋转($OR=0.354, P=0.015$)、Risser征($OR=3.043, P=0.032$)、主弯矫正率/柔韧性($OR=4.538, P=0.002$)、下胸弯Cobb角($OR=0.425, P=0.14$, 表 3)。建立的回归模型为 $Y=1/[1+\exp(-1.182X_1+1.228X_2+1.671X_3-0.71X_4+0.407)]$ 。由此可得知, 椎体旋转、Risser征、主弯矫正率/柔韧性、下胸弯Cobb角等是Lenke II型青少年特发性脊柱侧凸患者固定后发生冠状面失平衡的独立危险因素。

3 讨论 Discussion

近年来, 随着国内医务工作者对脊柱侧凸的认识逐渐加深, 以及影像学及配套设备的长足发展, 全脊柱正侧位平片逐渐成为筛选青少年特发性脊柱侧凸的首选方法。同时, Lenke等^[5]提出的结构性弯与非结构性弯的概念进一步的增强了医生对手术适应症的把握。全脊柱正侧位平片以

表 2 Lenke II 型青少年特发性脊柱侧凸患者固定后冠状面失平衡原因的卡方分析结果

Table 2 Chi-square analysis results of reasons for postoperative coronal plane imbalance in Lenke type II adolescent idiopathic scoliosis patients

项目	正常	失平衡	统计学分析结果
年龄			
11-15 岁	47	15	$P=0.293 > 0.05$
15-19 岁	64	15	
民族			
汉族	46	12	$P=0.529 > 0.05$
非汉族	65	18	
身高			
165 cm 以下	59	13	$P=0.227 > 0.05$
165 cm 以上	52	17	
Nash-More 椎体旋转			
0-2 级	65	10	$P=0.012 < 0.05$
3-4 级	46	20	
Risser 征			
0-3 级	69	25	$P=0.022 < 0.05$
4-5 级	42	5	
主弯矫正率/柔韧性			
比值>1	52	24	$P=0.001 < 0.05$
比值 0-1	59	6	
双侧锁骨最高点连线与 水平线夹角			
0-5°	81	18	$P=0.125 > 0.05$
> 5°	30	12	
双侧骨盆最高点连线与 水平线夹角			
0-5°	92	23	$P=0.296 > 0.05$
> 5°	19	7	
固定前冠状面过 C ₇ 棘突的铅垂线与骶骨 中线的水平距离			
< 2 cm	99	24	$P=0.151 > 0.05$
> 2 cm	12	6	
上胸弯 Cobb 角			
< 60°	76	17	$P=0.160 > 0.05$
> 60°	35	13	
下胸弯 Cobb 角			
< 70°	64	11	$P=0.033 < 0.05$
> 70°	47	19	

及全脊柱左右侧屈位(Bending像)上测量Cobb角的方法为青少年特发性脊柱侧凸的诊断提供了可靠的依据。但是, 随着年龄的进展, 青少年特发性脊柱侧凸患者Cobb角亦随之增大, 由此不少医务工作者将注意力全部放在Cobb角上, 并将Cobb角的大小与青少年特发性脊柱侧凸的严重程度画上等号, 这也就造成只注重Cobb角的矫正, 而不注重躯体平衡再塑造的恶劣局面。

既往研究资料显示, 青少年特发性脊柱侧凸患者冠状面的失衡程度与生活质量恶化成正相关^[48-54]。有学者认为在冠状面上当冠状面过C₇棘突的铅垂线与骶骨中线的水平距离> 20 mm时, 即有发生躯体冠状面失平衡的危险^[55]。因此, 实验采用固定后冠状面过C₇棘突的铅垂线与骶骨中线的水平距离> 20 mm, 即躯干偏移> 20 mm作为固定后躯体冠状面失平衡的标准。

表 3 青少年特发性脊柱侧凸患者固定后出现冠状面失平衡影响因素的 logistic 回归分析结果

Table 3 Results of logistic regression analysis of influential factors for postoperative coronal plane imbalance in patients with adolescent idiopathic scoliosis

项目	B	S.E.	Wald	Sig.	Exp(B)	95% CI for EXP(B)	
						Lower	Upper
Nash-More 椎体旋转	-1.182	0.486	5.928	0.015	0.307	0.118	0.794
Risser 征	1.228	0.572	4.6	0.032	3.413	1.112	10.482
主弯矫正率/柔韧性	1.671	0.531	9.882	0.002	5.316	1.876	15.065
下胸弯 Cobb 角	-0.71	0.481	2.174	0.14	0.492	0.191	1.263
常数	0.407	1.234	0.109	0.741	1.503		

Lenke等^[56]对50例患者行选择性胸腰弯融合, 固定中采用CD钩内固定系统, 固定后1年出现冠状面失代偿患者5例, 其中3例需翻修手术。Puno等^[57]报道具有2年以上完整随访资料的183例青少年特发性脊柱侧凸患者中, 均采取内固定矫形治疗, 固定后出现冠状面失平衡的共有37例(20.2%)。Lenke等^[56]报道在后路选择性胸椎融合治疗青少年特发性脊柱侧凸66例, 应用椎板钩或钉棒内固定系统, 有17例患者出现了冠状面失平衡。Suk等^[58]对青少年特发性脊柱侧凸患者在选择性胸椎融合方案中使用节段性椎弓根螺钉进行治疗, 具有5年以上完整随访资料的有236例, 冠状面失平衡的发生率为11.4%。Little等^[59]报道行后路椎弓根螺钉固定治疗青少年特发性脊柱侧凸, 获得2年以上完整随访资料的24例, 发生固定后失平衡的4例(16.7%)。作者所在课题组完整随访患者141例, 冠状面失平衡30例, 发生率21.28%, 略高于Puno等^[57]的报道, 与Lenke等^[56]及Li等^[10]的报道基本持平。

近来虽有学者提出, 青少年特发性脊柱侧凸矫形术的首要目标是重建矢状面平衡, 但冠状面的平衡再造亦非常重要。McCance等^[60]提出冠状面过C₇棘突的铅垂线与骶骨中线的水平距离的理想值是 ≤ 2 cm。但由于冠状面过C₇棘突的铅垂线与骶骨中线的水平距离属于线性测量, 测量误差较大, 与平片质量、测量者本身以及被拍摄者手臂放置位置遮挡等均有较大关系, 因此作者结合近期国内外文献筛选出11个可能导致患者固定后冠状面失平衡的因素进行卡方检验, 获得4个出现组内统计学差异的因素, 再对上述因素进行Logistic回归分析确定青少年特发性脊柱侧凸固定后冠状面失平衡的危险因素, 以此作为固定前判断患者可能造成固定后冠状面失平衡的参考。

实验中固定前Nash-More椎体旋转、Risser征、主弯矫正率/柔韧性、下胸弯Cobb角度等是造成固定后患者出现冠状面失平衡的危险因素, 作者分析可能与以下原因有关: ①对于3-4级的Nash-More椎体旋转的患者, 固定中因旋棒及其他手术方法所造成的椎体旋转矫正度数较0-2级的Nash-More椎体旋转的患者更大, 由此所造成的固定后脊柱纵向力线的改变、椎旁肌所受累程度均与固定前有较大差异, 且由于置入坚强的内固定装置, 椎旁肌不足以抵抗强大的内固定所产生的失代偿, 故出现固定后冠状面失平衡现象。②对于0-3级Risser征的患者, 因固定后躯体生长发育的不确定性造成的躯体失稳远较躯体生长发育已趋于稳定的4-5级Risser征患者大, 故固定后发生冠状面失平衡的概率也较高。③对于主弯矫正率相同的青少年特发性脊柱侧凸患者, 良好的主弯柔韧性可最大限度的改善脊柱畸形的程度, 同时对于脊柱平衡的再造及固定后椎旁肌功能的恢复起到重要的作用。反之, 对于固定前Bending像提示柔韧性差的青少年特发性脊柱侧凸患者, 固定中矫形难度加大, 同时为减少固定后出现内固定装置松动或断裂的风险, 增加椎弓根螺钉的数量及延长固定节段是必不可

少的, 这进一步减少了脊柱及机体自身的代偿, 增大了固定后冠状面失平衡的风险。

对于固定前双肩或双侧骨盆不等高的患者, 进行脊柱侧弯矫形或截骨固定往往不会增加双肩或双侧骨盆倾斜的严重程度。且由于置入强大的椎弓根螺钉内固定系统, 因矫形所造成的椎旁肌或椎旁附属结构的牵拉引起脊柱失稳的程度可明显减轻, 明显低于椎板钩系统及Harrington棒系统, 故固定前双肩、双侧骨盆及固定前及固定后冠状面过C₇棘突的铅垂线与骶骨中线的水平距离均不是构成固定后青少年特发性脊柱侧凸患者冠状面失平衡的危险因素。

随访中, 部分患者虽固定后全脊柱正位片提示冠状面失平衡, 但同期患者对手术矫形效果较为满意, 这提示影像学检查与手术矫形效果具有差异。由于患者并非以矫正Cobb角为目的行矫形手术, 而是以纠正身体形态作为最终目标, 故不能完全以影像学中冠状面的失平衡来衡量手术的成功与否。因此, 加大对固定后身体形态观的恢复的认识尤为重要。

实验尚有不足之处。首先, 缺乏5年以上远期随访记录, 因此有待于进一步证实固定后冠状面失代偿水平能否随着时间的推移而改变。第二, 各组病历较有限, 缺乏大样本量研究, 有待日后相关研究进一步开展。尽管有以上不足, 但该研究对临床上几乎所有对青少年特发性脊柱侧凸患者有影响的因素进行分析, 通过回归分析确定4个可能导致青少年特发性脊柱侧凸患者固定后冠状面失平衡的危险因素, 为临床上进一步认识固定后冠状面失平衡, 特别是如何预防或减少固定后出现冠状面失平衡提供了相关参考依据。对于青少年特发性脊柱侧凸患者, 固定前认真评估全脊柱正侧位及全脊柱过伸过屈位平片, 综合各方面因素全面分析, 详细制定置钉方案, 方有利于手术疗效的提高。

作者贡献: 所有作者共同进行实验设计、实施及评估。

利益冲突: 文章及内容不涉及相关利益冲突。

伦理要求: 实验获得所有参与者及家属的知情同意, 并获得新疆医科大学第一附属医院伦理学委员会的批准。

学术术语: 青少年特发性脊柱侧凸-是发生于青春期发育前后的最常见的脊柱畸形, 病主要包括遗传学机制、激素的作用、结缔组织异常、生长不对称及生物力学作用等, 但并无统一的病因学解释。

作者声明: 文章为原创作品, 无抄袭剽窃, 无泄密及署名和专利争议, 内容及数据真实, 文责自负。

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