临床论著

成人脊柱畸形术前冠状面失平衡及其与脊柱-骨盆影像学参数的关系

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【摘要】目的:测量成人脊柱畸形(adult spinal deformity, ASD)患者术前脊柱-骨盆参数,探讨 ASD 患者术前脊柱-骨盆参数与冠状面失衡的相关性。**方法**:回顾分析 161 例 ASD 患者的术前影像学资料,在站立位脊柱全长正、侧位 X 线片上测量影像学参数,冠状位参数包括主弯角度(Cobb 角)、代偿弯角度(compensatory angle, C-Cobb 角)、侧凸方向 (左或右)、侧凸累及椎体数 (vertebra number, VN)、侧凸椎体半脱位程度(subluxation degree, SD)、侧凸顶椎旋转度 (apex rotation, AR)、顶椎位置、C7 铅垂线 (C7PL) 到 S1 中点的距离(coronal balance distance, CBD);矢状位参数包括胸椎后凸角(TK)、胸腰段后凸角(TLK)、腰椎前凸角(LL)、骶骨角(SS)、骨盆倾斜角(PT)、骨盆入射角(PI)、矢状面平衡(SVA)。将患者分为失衡组(CBD>30.00mm, A 组)和平衡组(CBD<30.00mm, B 组)χ^2 检验比较两组患者比例参数, t 检验比较两组影像学参数。**结果**:161 例 ASD 患者的年龄为 45~79 岁(63.9±8.4 岁),男女比为 29:132(M:F),侧凸方向 106:55(左:右),冠状面失衡组 31 例(男 8 例,女 23 例),平衡组 130 例(男 21 例,女 109 例),总失衡率为 19.25%(31/161)。侧凸顶椎大多处于 L2~L3 节段,约占 75.16%(121/161)。失衡组和平衡组患者年龄、性别比、左右侧凸比例、TK、TLK、LL、SS、PT、PI 及 SVA 均无显著性差异(P>0.05),两组侧凸顶椎位置有显著性差异(χ^2=12.692, P<0.001),失衡组顶椎位置均处于 L2~L3 节段;两组患者主弯及代偿弯 Cobb 角均无显著性差异(P>0.05),但失衡组患者 NV 少于平衡组(3.87±0.85 vs 4.36±0.95; t=2.639, P=0.009);失衡组患者 AR 大于平衡组(2.81±0.60 vs 2.32±0.77; t=-3.796, P<0.001),TLK 大于平衡组(t=-2.445, P=0.017)。将顶椎处于 L2~L3 节段的 121 例患者分为失衡组(CBD>30.00mm, A′组, 31 例)和平衡组(CBD<30.00mm, B′组, 90 例),两组主弯 Cobb 角、C-Cobb 角无显著性差异(P>0.05);A′组患者主弯累及椎体数明显少于 B′组 (3.87±0.85 vs 4.23±0.85; t=2.052, P=0.04);A′组患者 AR 明显大于 B′组 (2.81±0.60 vs 2.27±0.68; t=-3.905, P<0.001)。**结论**:约 1/5 的 ASD 患者术前冠状面失平衡,且侧凸顶椎均位于 L2~L3 节段;侧凸角度相似、顶椎旋转度较大、侧凸累及椎体数目较少的患者更易出现冠状位失平衡。

【关键词】成人脊柱畸形;冠状位失平衡;影像学参数;冠状位平衡距离
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【Abstract】Objectives: To explore the prevalence of coronal imbalance, and to demonstrate the relationship between coronal imbalance and spine-pelvic parameters by investigating the pre-operative radiographic parameters in adult spinal deformity (ASD). **Methods:** A total of 161 patients with ASD in our hospital was reviewed. The radiographic parameters were measured on the pre-operative anteroposterior and lateral spinal radiographs. Parameters on coronal plane included curve angle(Cobb), compensatory angle(C-Cobb), types of curvature(left or right), the involved vertebrae and the subluxation degree of structural curvature, the degree of apical vertebra rotation(AR), coronal pelvic tilt angle(C-PT), coronal balance distance(CBD): the coronal offset between C7PL and the center of S1 endplate. Parameters on sagittal plane included thoracic kyphosis (TK), thoracolumbar kyphosis(TLK), lumbar lordosis(LL), sacral slope(SS), pelvic tilt(PT), pelvic incidence(PI), sagittal

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vertical axis(SVA). Patients were divided into two groups, group A(the imbalance group, CBD>30.00mm) and group B (CBD<30.00mm). Radiographic parameters in imbalance and balance group were compared by using independent samples *t*-test. The ratio of gender, and the types of curve in the two groups were compared by using χ^2-tset. **Results:** All the 161 patients were included in this study, 29 males(M) and 132 females(F), with the age ranging from 45 to 79 years(63.9±8.4 years). Among them, 106 patients had left side curve, and the other 55 patients had right side curve. Coronal imbalance occurred in 31 patients(M:F, 8:23), but did not occure in the other 130 patients(M:F, 21:109). The coronal imbalance rate was 19.25%(31/161). The age, gender, types of curve, TK, TLK, LL, SS, PT, PI and SVA in the two groups had no significant differences(P>0.05). The location of apical vertebra had significant difference between the two groups(χ^2=12.692, P<0.001), the apical vertebrae were all located at L2 to L3 segments. Although the Cobb degree of the structural and the compensatory curvature in the two groups had no difference respectively (P>0.05), the involved vertebrae were less in group A than those in group B(3.87±0.85 vs 4.36±0.95, t=2.639, P=0.009), and the degree of apical vertebra rotation in group A was much more than that in group B (2.81±0.60 vs 2.32±0.77, t=-3.796, P<0.001). The thoracolumbar kyphosis degrees in group A were much bigger than those in group B(t=-2.445, P=0.017). The 121 patients whose apical vertebra located at L2 to L3 segment were divided into two groups, group A′(the imbalance group, CBD>30.00mm) including 31 patients and group B′(CBD<30.00mm) including 90 patients. The curve angle(Cobb), the compensatory angle(C-Cobb), the involved vertebrae and the subluxation degree of structural curvature, and the degree of apical vertebra rotation (AR) of the two groups were compared by using independent samples *t*-test respectively. The similar results were found: although the Cobb degree of the structural and the compensatory curvature had no significant difference respectively(P>0.05), the involved vertebrae were less in group A′ than those in group B′(3.87±0.85 vs 4.23±0.85, t=2.052, P=0.04), and the degree of apical vertebra rotation in group A′ was much more than that in group B′(2.81±0.60 vs 2.27±0.68, t=-3.905, P<0.001). **Conclusions:** The prevalence of pre-operative coronal imbalance in ASD patients is about 20%. The apical vertebrae of the structural curvatures locate at L2 to L3 segments. The patients who have more rotation degrees, less involved vertebrae, may more easily suffer from coronal imbalance.

【Key words】 Adult spinal deformity; Coronal imbalance; Radiological parameters; Coronal balance distance

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成人脊柱畸形（adult spinal deformity，ASD）是一类较为复杂的疾病，不但有骨骼、肌肉及神经系统病理生理学改变，而且还涉及人体生物力学变化[1,2]。ASD 常引起矢状位和冠状位失衡、姿势改变，并导致背痛、下肢放射痛等神经症状[3,4]。既往研究显示冠状位平衡距离与患者健康生活质量明确相关[5,6]。Bao 等[7]的研究发现，术后冠状位失衡患者的功能评分如疼痛视觉模拟评分（VAS）、Oswestry 功能残障指数（ODI）及生活质量评价量表 SF-36 评分等明显差于平衡患者。迄今为止，国内外对此类患者术前冠状位侧凸参数与冠状面平衡相关性的研究少见。我们对 161 例 ASD 患者手术前的全脊柱影像学参数进行了系统测量，旨在揭示手术前脊柱冠状位平衡状态，分析 ASD 患者脊柱-骨盆参数与冠状位失平衡的相关性。

1 资料与方法

1.1 一般资料

病例纳入标准：2015 年 1 月~2017 年 12 月在我院诊治的成人脊柱畸形（ASD）患者，年龄≥45 岁，影像学资料完整。排除标准：青少年特发性脊柱侧凸成人期，有脊柱肿瘤、结核、峡部裂型滑脱、骨盆外伤史、脊柱手术史、髋膝关节手术史者，下肢长度差距>2.0cm 者，非结构性侧后凸者。研究方案经我院伦理委员会审批通过。收集患者术前脊柱全长正侧位 X 线平片。

1.2 影像学资料及测量

标准站立位脊柱全长正、侧位X 线片拍摄方法[8]：放松站立、双侧上肢上抬 45°、双手搭在对侧肩关节及锁骨上。所有影像学资料由一名脊柱外科主治医师测量，测量工具为 Surgimap（version：2.2.14.3）。测量参数：（1）侧凸 Cobb 角，上端椎上

终板与下端椎下终板夹角;(2) 冠状位平衡差距(coronal balance distance,CBD)[7],C7 铅垂线(C7PL)与骶骨中分线(CSVL)的距离;(3)顶椎位置、椎体旋转度(Nash-Moe 法);(4)侧凸累及椎体数(vertebra number,VN);(5)侧凸椎体半脱位程度 (subluxation degree,SD)(参考 Meyerding 分度法);(6)代偿弯 Cobb 角(compensatory Cobb angle,C-Cobb), 上端椎上终板与下端椎下终板夹角;(7)冠状面骨盆倾斜角(coronal pelvic tilt angle,C-PT),两侧髂骨最高点连线与水平线成角[9];(8)胸椎后凸角(thoracic kyphosis,TK),T4 椎体上终板与 T12 椎体下终板 Cobb 角;(9)胸腰椎后凸角 (thoracolumbar kyphosis,TLK),T10 椎体上终板与 L2 椎体下终板 Cobb 角;(10)腰椎前凸角(lumber lordosis,LL),L1 椎体上终板与 S1 椎体上终板 Cobb 角;(11) 骶骨倾斜角 (sacral slope,SS),S1 终板与水平线夹角;(12) 骨盆倾斜角(pelvic tilt,PT),S1 上终板中点与两股骨头中点连线与铅垂线的夹角;(13)骨盆指数(pelvic incidence,PI),经 S1 上终板中点做上终板垂线,然后做 S1 上终板中点与双侧股骨头中点连线,两线夹角;(14)矢状面平衡(sagittal vertical axis,SVA),C7 椎体垂线与骶骨后上角距离,C7 垂线落在骶骨后缘前方为+,后方为-。测量方法详见图 1~5。

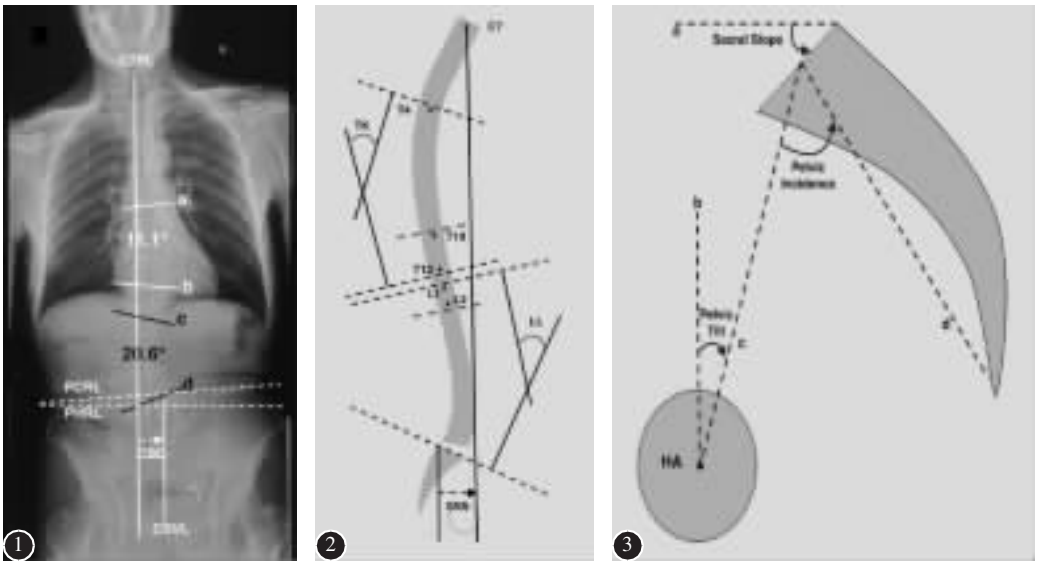

图 1 影像学参数测量方法:主弯,c、d 线之间的夹角(Cobb 法);代偿弯,a、b 之间的夹角(Cobb 法);冠状位平衡差距(CBD),C7 椎体垂线与骶骨中垂线距离;冠状面骨盆倾斜角(C-PT),两侧髂骨最高点即骨盆冠状面参考线(PCRL)与骨盆水平线(PHRL)两线夹角 **图 2** 矢状位参数测量示意图:胸椎后凸角(TK),T4 椎体上终板切线与 T12 椎体下终板切线成角(Cobb 法);胸腰椎后凸角(TLK),T10 椎体上终板切线与 L2 椎体下终板切线成角(Cobb 法);腰椎前凸角(LL),L1 椎体上终板切线与 S1 上椎板切线成角(Cobb 法);矢状面平衡(SVA),C7 椎体铅垂线到骶骨后上角距离 **图 3** 骨盆参数测量示意图:骶骨倾斜角(SS),S1 椎体上终板切线与水平线 a 的成角;骨盆倾斜角(PT),股骨头中心连线中点与 S1 上终板中点连线 c 与垂线 b 成角;骨盆入射角(PI),股骨头中心连线中点与 S1 上终板中点连线 c 与 S1 上终板垂线 d 成角

Figure 1 Structual lumbar curve, from line c to line d by Cobb method; compensatory thoracic curve, from line a to line b by Cobb method; coronal balance distance(CBD), the distance between C7 plumb line(C7PL) and center sacral vertical line(CSVL); coronal pelvic tilt angle(C-PT), the angle between the pelvic coronal reference line(PCRL) and the pelvic horizontal line(PHL) by angle-off method **Figure 2** Sagittal radiologic parameters: thoracic kyphosis(TK), from the superior endplate of T4 to the inferior endplate of T12 by Cobb method; thoracolumbar kyphosis(TLK), from the superior endplate of T10 to the inferior endplate of L2 by Cobb method; lumbar lordosis(LL), from the superior endplate of L1 to the inferior endplate of S1 by Cobb method; sagittal vertical axis(SVA), the horizontal offset from the posterosuperior corner of S1 to the vertebral body of C7 **Figure 3** Pelvic parameters: sacral slope(SS), the angle between the horizontal line and the sacarl endplate; pelvic tilt(PT), the angle between the vertical and the line through the midpoint of the sacral endplate to the femoral heads axis; pelvic incidence (PI), the angle between the perpendicular to the sacral plate at its midpoint and the line connecting this point to the femoral heads axis

1.3 分析方法

根据既往研究[10],将患者分为失衡组(CBD>30.00mm,A 组)和平衡组(CBD<30.00mm,B 组)。再将顶椎处于 L2~L3 节段的 121 例患者按以上标准进一步分为 A′组(失衡组:CBD>30.00mm)和 B′组(平衡组:CBD<30.00mm)。计量数据采用 $\bar{x}\pm s$ 表示,所有数据选用 SPSS 23.0 (Mac 版 IBM© SPSS® Statistics)软件分析处理。独立样本 t 检验比较相关定量参数,χ^2 检验分析两组性别比及侧凸方向比例,P<0.05 为有统计学差异。

2 结果

共纳入 161 例 ASD 患者,年龄为 45~79 岁(63.9±8.4 岁),男 29 例,女 132 例。侧凸方向:左 106 例,右 55 例。侧凸顶椎分布:L1 6 例,L1/2 19 例,L2 36 例,L2/3 54 例,L3 31 例,L3/4 12 例,

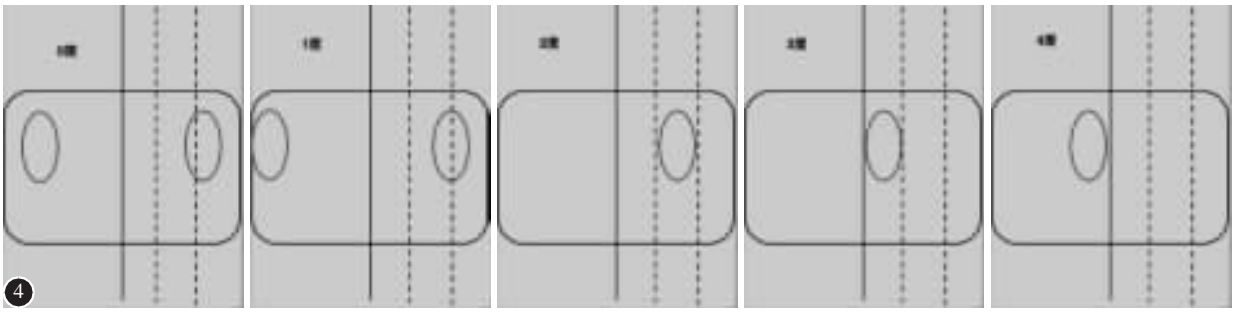

图 4 椎体旋转度评估方法(Nash-Moe 法,4 度 5 分法):0 度,椎体无旋转,两侧椎弓根投影对称;1 度,凹侧椎弓根投影较凸侧更近椎体边缘,且大部分凸侧椎弓根投影未超越椎体外 1/3;2 度,凹侧椎弓根投影消失,凸侧椎弓根投影处于椎体中 1/3 处;3 度,凸侧椎弓根投影处于内 1/3 处于但未超越中线;4 度,凸侧椎弓根投影超越中线

Figure 4 Nash-Moe method categorizes vertebral rotation into 5 level. According to this method, the vertebra is first bisected longitudinally and then each half is further divided into 3 equal portions. No significant vertebral rotation exists when the distance from the vertebral pedicle shadow to the bilateral edges of the vertebral body is equal, indicating that the Nash-Moe grade is 0. There is significant vertebral rotation when the vertebral pedicle shadow on the concave side is closer to the edge than that on the convex side, or disappears completely. Grade 1 is defined when most of the vertebral pedicle shadow on the convex side is still within the one-third of the edge portion; grade 2 is defined when it is within the one-third of the central portion; grade 3 is refined when it is within to one-third portion close to the midline; grade 4 is defined when it exceeds the midline

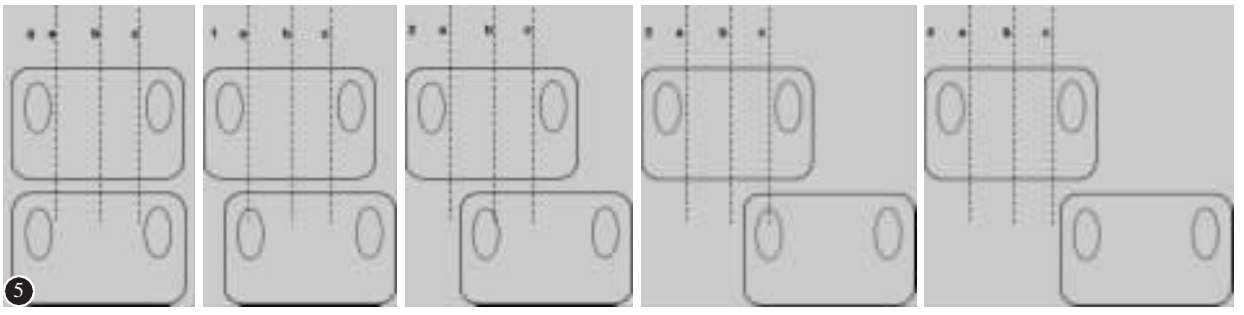

图 5 椎体脱位程度评价方法(Meyerding 分度法):将上位椎体以 a、b、c 线平分为 4 份,0 度,冠状位上、下椎体外缘对应良好;Ⅰ度,下位椎体横向滑移,但外缘未超过线 a;Ⅱ度,下位椎体横向滑移,但外缘未超过线 b;Ⅲ度,下位椎体横向滑移,但外缘未超过线 c;Ⅳ度,下位椎体横向滑移,但外缘超过线 c

Figure 5 The superior vertebra is divided into 4 parts equally by line a, b, and c. No significant vertebral shifting exists, the outer edges of the superior and inferior vertebra are in a same line, indicating that the grade is 0;Grade Ⅰ is defined when the outer edge of the inferior vertebra shifts on the coronal plane within line a;Grade Ⅱ is defined when the outer edge of the inferior vertebra exceeds line a but within line b; Grade Ⅲ is defined when the outer edge of the inferior vertebra exceeds line b but within line c; Grade Ⅳ is defined when the outer edge of the inferior vertebra exceeds line c

L4 3 例。

31 例患者冠状面失平衡（失衡组,A 组,图 6),男 8 例,女 23 例;130 例患者冠状面平衡(平衡组,B 组,图 7),男 21 例,女 109 例。失衡率为 19.25%(31/161)。两组患者的一般资料和影像学参考数见表 1。两组患者性别比、左右侧凸比例均无显著性差异(P>0.05)。行独立样本 t 检验,患者年龄、C-PT、TK、LL、SS、PT、PI、SVA 均无显著性差异(P>0.05);两组侧凸顶椎位置有显著性差异(χ^2=12.692,P<0.001),失衡组顶椎位置均处于 L2~L3 节段。两组患者术前主弯角度、代偿弯角度(C-Cobb)无显著性差异(P>0.05),但 A 组患者主弯累及椎体数显著性少于 B 组（t=2.639,P=0.009),A 组患者侧凸顶椎旋转度显著性大于 B

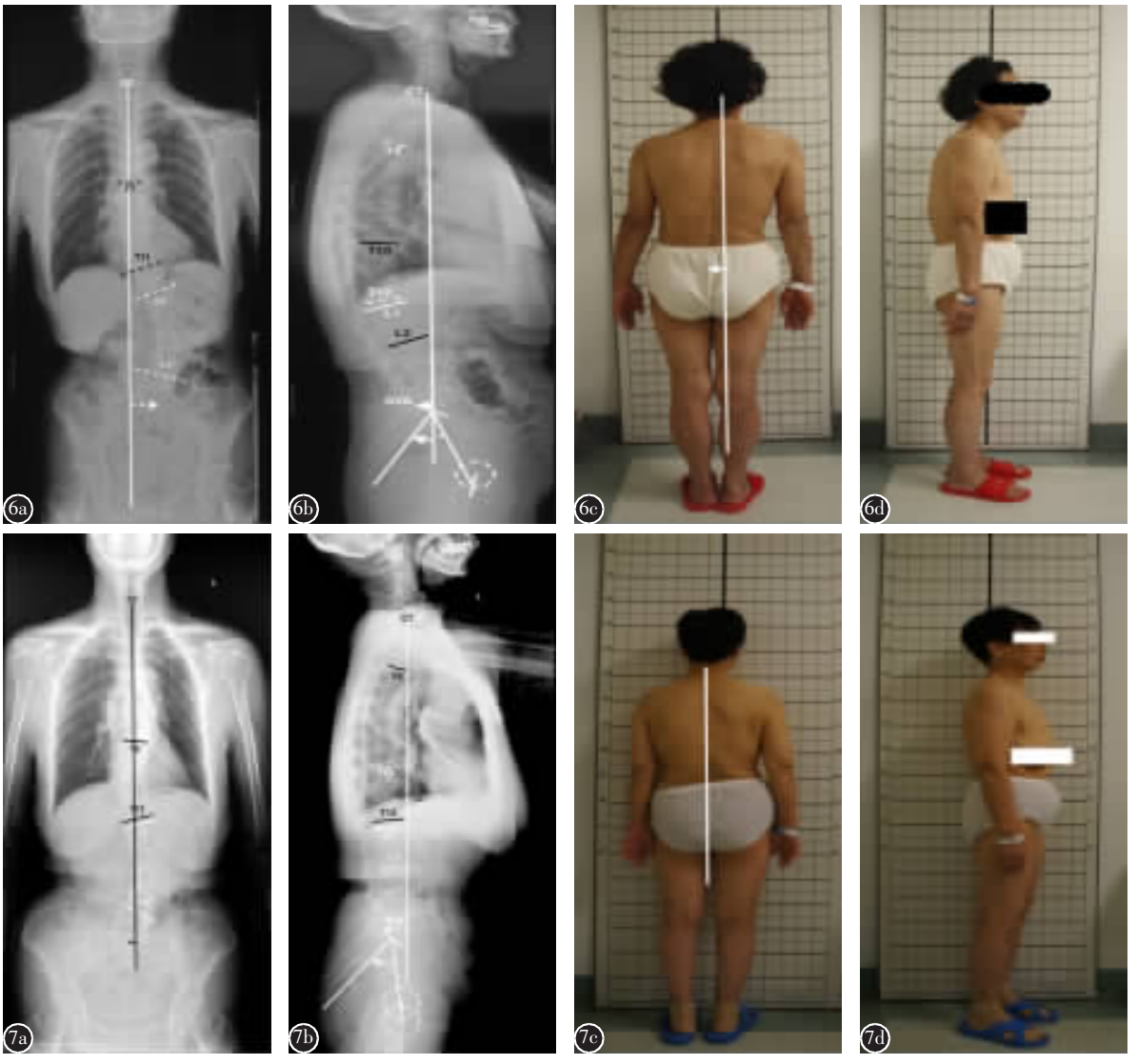

图 6 患者女,74 岁,成人脊柱畸形。术前正侧位 X 线片示侧凸 Cobb 角 41.6°,顶椎 L2/3,旋转 3 度,CBD 69.5mm, TK 22.9°,TLK 32.2°,LL 41.6°,SS 28.7°,PT 23.3°,PI 52.0°,SVA 31.4mm;大体像示冠状面失平衡 **图 7** 患者女,71 岁,成人脊柱畸形。术前正侧位 X 线片示侧凸 Cobb 角 19.2°,顶椎 L3,旋转 2 度,CBD 10.9mm,TK-21.2°,TLK 22.4°,LL 7.8°,SS 5.7°,PT 18.9°,PI 24.6°,SVA 62.5mm;大体像示冠状面平衡

Figure 6 This patient had adult spinal deformity, belonging to group A, 74 years-old lady, anteroposterior and lateral radiographs, Cobb angle -41.6°, Apical vertebra L2/3, Apex rotation -3 degree, Coronal balance distance 69.5mm, TK 22.9°, TLK 32.2°, LL 41.6°, SS 28.7°, PT 23.3°, PI 52.0°, SVA 31.4mm **Figure 7** This patient had adult spinal deformity, belonging to group B, 71 years-old lady, anteroposterior and lateral radiographs, Cobb angle 19.2°, Apical vertebra L3, Apex rotation 2 degree, Coronal balance distance 10.9mm, TK -21.2°, TLK 22.4°, LL 7.8°, SS 5.7°, PT 18.9°, PI 24.6°, SVA 62.5mm

组(t=−3.796, P<0.001), TLK 显著性大于 B 组(t=−2.445, P=0.017)。

将顶椎处于 L2~L3 节段的 121 例 ASD 患者分为失衡组(CBD>30.00mm, A′组, 31 例)和平衡组(CBD<30.00mm, B′组, 90 例), 两组患者的一般资料和影像学参数见表 2。比较两组相关参数, 结果与上相同: 主弯、代偿弯角度、TK、LL、SS、PT、PI 及 SVA 均无显著性差异(P>0.05); A′组患者主弯累及椎体数显著性少于 B′组 (t=2.052, P=0.04); A′组患者侧凸顶椎旋转度显著性大于 B′组 (t=−3.905, P<0.001)。

3 讨论

近年来, 随着对 ASD 认识日益深入, 发现矢状面和冠状面平衡对于 ASD 患者同等重要[11,12]。随着疾病进展, 脊柱整体失平衡会引起患者不适感、机体功能下降及腰背痛, 生活质量低下[13]。Schwab 等[14]改进的 ASD 分型综合考虑了脊柱矢状位和冠状位参数, 且证明该分型具有较高的可信度, 因此, 我们应同等重视冠状位与矢状位相关参数。

本研究纳入了 161 例 ASD 患者, 所有患者平均年龄 63.9 岁, 女性患者比例远高于男性 (女:男=132:29), 和既往国内外研究一致[15,16]。所有患者主弯均处于腰段, 侧凸顶椎大多处于 L2~L3 水平 (L2 36 例, L2/3 54 例, L3 31 例), 占总体 75.16%(121/161), 其余见于 L1 或 L4 节段, 胸椎罕见, 和既往研究类似[13,15]。一定程度上说明此类疾病发病起始于腰椎。

既往对 ASD 患者冠状位失平衡做了许多研

表 1 A 组与 B 组患者参数

Table 1 The parameters of the patients in group A and B

	A组(n=31) Group A	B组(n=130) Group B
性别(男:女) Gender(M:F)	8:23	21:109
左侧凸:右侧凸 Left:Right	22:9	84:46
年龄(岁) Age(years)	63.52±10.64	63.96±7.84
侧凸角度(°) Cobb angle	28.28±11.40	26.66±9.84
代偿弯角度(°) C-Cobb angle	17.08±10.00	14.40±6.25
顶椎旋转度(°) AR	2.81±0.60	2.32±0.77①
椎体半脱位(°) VS	0.87±0.72	0.78±0.70
累及椎体数 Vertebras	3.87±0.85	4.36±0.95①
冠状位平衡 CBD(mm)	40.99±12.39	9.48±6.39①
骨盆倾斜(°) C-PT	2.53±1.83	2.23±1.77
胸椎后凸角 TK(°)	14.94±11.28	17.46±13.66
胸腰椎后凸角 TLK(°)	23.68±9.17	18.53±14.97①
腰椎后凸角 LL(°)	21.85±22.54	24.14±17.41
骶骨倾斜角 SS(°)	20.78±14.01	23.91±13.75
骨盆倾斜角 PT(°)	23.43±10.71	23.93±9.91
骨盆入射角 PI(°)	44.20±13.72	48.07±12.05
矢状位平衡 SVA(mm)	50.98±52.10	39.05±45.71

注:①与 A 组比较 P<0.05

Note: ①Compared with group A, P<0.05

表 2 A′组与 B′组患者参数

Table 2 The parameters of the patients in group A′ and B′

	A′组(n=31) Group A	B′组(n=90) Group B
性别(男:女) Gender(M:F)	8:23	21:75
左侧凸:右侧凸 Left:Right	22:9	64:36
年龄(岁) Age(years)	63.52±10.64	62.97±8.13
侧凸角度(°) Cobb angle	28.28±11.40	26.96±8.71
代偿弯角度(°) C-Cobb angle	17.08±10.00	13.95±5.18
顶椎旋转度(°) AR	2.81±0.60	2.27±0.68①
椎体半脱位(°) VS	0.87±0.72	0.77±0.77
累及椎体数 Vertebras	3.87±0.85	4.23±0.85①
冠状位平衡 CBD(mm)	40.99±12.39	8.88±6.07①
骨盆倾斜(°) C-PT	2.53±1.83	2.17±1.67
胸椎后凸角 TK(°)	14.94±11.28	14.52±12.03
胸腰椎后凸角 TLK(°)	23.68±9.17	17.05±14.19①
腰椎后凸角 LL(°)	21.85±22.54	23.87±18.47
骶骨倾斜角 SS(°)	20.78±14.01	25.24±12.79
骨盆倾斜角 PT(°)	23.43±10.71	22.8±10.1
骨盆入射角 PI(°)	44.20±13.72	48.37±11.66
矢状位平衡 SVA(mm)	50.98±52.10	41.42±41.36

注:①与 A′组比较 P<0.05

Note: ①Compared with group A′, P<0.05

究，如 Schwab 等[17]的早期研究揭示了 ASD 患者冠状位参数与其生活质量的相关性。此后，多位学者研究了冠状位失衡与生活质量的相关性[6,10,18]，且有学者提出了 ASD 患者术前冠状面失平衡分型及对术后冠状面平衡的影响[7]，但既往研究都未能对 ASD 患者冠状位平衡的影响因素做进一步分析。

本研究将所有患者根据冠状位平衡距分组，两组患者相关参数对照，主弯角度无差异，但是失衡组患者累及的椎体数明显少于平衡组（P=0.009），两组患者侧凸顶椎位置有显著性差异，失衡组侧凸顶椎均处于 L2~L3 节段（P<0.001），且顶椎旋转度明显大于平衡组（P<0.001）。进一步筛选出 121 例顶椎处于 L2~L3 节段的 ASD 患者，并根据 CBD 分组比较，结果与上一对照相同，主弯、代偿弯角度无显著性差异（P>0.05）；失衡组（A′组）患者主弯累及椎体数明显少于平衡组（B′组）（P=0.04），侧凸顶椎旋转度明显大于 B′组（P<0.001）。既往研究[19]发现由于脊柱生物力学机制，侧凸累及节段越多、顶椎旋转越大，冠状面侧凸角度将越大，这可能是脊柱为保持整体平衡所产生了一种代偿机制所致。从我们的研究结果可以推出，当侧凸角度相近，累及椎体数较少，且侧凸顶椎旋转度较大时，冠状面脊柱整体平衡极可能出现失代偿，从而出现冠状面失平衡。

既往有研究[20]显示，ASD 患者侧凸与后凸间存在一定相关性。本研究发现 A 组（失衡组）患者矢状位胸腰段后凸角（TLK）明显大于 B 组（平衡组）（P=0.017），说明 ASD 患者冠状位失衡同时伴有胸腰椎后凸加重。侧凸顶椎位置相同（L2~L3 节段）时，失衡组与平衡组患者 TLK 差异进一步加大（P=0.004），进一步证实该观点。此外，本研究发现两次对照冠状位失衡组与平衡组患者矢状位相关参数及骨盆参数均无显著性差异，说明冠状位的侧凸畸形不会影响矢状位的形态学参数，这与既往研究结果一致[18]。

综上所述，ASD 在女性高发，患者侧凸顶椎大多处于 L2~L3 节段，术前冠状面失平衡普遍存在，约占 1/5。对于侧凸 Cobb 角度相似的 ASD，冠状面失衡患者侧凸累及椎体数较少（平均少于 4 个）、侧凸顶椎旋转度较大，侧凸与后凸之间具有相关性。但本研究病例均来自单一诊疗中心，这可能会导致选择偏移。其次，虽然本研究纳入病例数量较大，然而根据冠状位平衡距（CBD）分组后失衡组患者仅有 31 例。此外，本项研究仅回顾分析了患者术前的影像学资料，未将患者功能评分纳入研究，未能探讨患者生活质量与影像学参数之间相关性。因此，需要进行大样本长期随访研究，进一步明确各参数变化，以进一步指导临床治疗。

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