

临床论著

后路凸侧椎板楔形截骨经肋椎关节松解
胸椎间隙治疗青少年重度脊柱侧后凸

李超, 于海洋, 付青松, 李海江, 尹稳, 王伟, 邹欣欣, 张伟, 刘彬

(安徽医科大学附属阜阳人民医院骨科 安徽省脊柱畸形临床医学研究中心 236000 阜阳市)

【摘要】目的:评价经后路凸侧椎板楔形截骨经肋椎关节松解胸椎间隙矫形治疗青少年重度脊柱侧后凸畸形的安全性和早期临床效果。**方法:**2014 年 5 月~2016 年 12 月对我院 15 例青少年重度脊柱侧后凸患者行经后路凸侧椎板楔形截骨经肋椎关节松解胸椎间隙手术治疗,术前仅 1 例严重脊柱侧后凸患者行头盆环牵引。男 6 例,女 9 例,年龄 13~18 岁(16.1 ± 1.6 岁)。其中先天性脊柱侧后凸 3 例,特发性 11 例,神经纤维瘤病性 1 例。术前侧凸 Cobb 角 $82^\circ\sim 144^\circ$ ($102.5^\circ\pm 17.6^\circ$),侧凸的柔韧性为 $6.4\%\sim 28.5\%$ ($21.56\pm 5.70\%$);后凸 $50^\circ\sim 95^\circ$ ($68.1^\circ\pm 15.3^\circ$),冠状位躯干偏移距离(C7 中垂线与骶骨中垂线距离) $2.0\sim 6.8\text{cm}$ ($3.40\pm 1.37\text{cm}$)。术前四肢肌力及感觉均正常。观察治疗效果。**结果:**椎板楔形截骨 5.20 ± 0.56 个(4~6 个),松解椎间隙 5.20 ± 0.56 个(4~6 个),手术时间 $6.1\sim 7.9\text{h}$ ($7.00\pm 0.51\text{h}$),术中出血量 $1050\sim 2500\text{ml}$ ($1450.0\pm 521.3\text{ml}$)。术后侧凸 Cobb 角 $18^\circ\sim 40^\circ$ ($28.0^\circ\pm 6.6^\circ$),矫正率 72.5%;后凸 $22^\circ\sim 42^\circ$ ($27.8^\circ\pm 6.1^\circ$),矫正率 58.4%;冠状位躯干偏移距离 $0\sim 2\text{cm}$ ($0.85\pm 0.74\text{cm}$),矫正率 72.8%。随访 25~41 个月(33.1 ± 5.4 个月)。末次随访时侧凸 Cobb 角 $19^\circ\sim 43^\circ$ ($30.0^\circ\pm 6.9^\circ$),矫正率 70.6%;后凸 $22^\circ\sim 42^\circ$ ($28.6^\circ\pm 6.5^\circ$),矫正率 57.2%;冠状位躯干偏移距离 $0.2\sim 2.3\text{cm}$ ($1.10\pm 0.72\text{cm}$),矫正率 71.3%。无胸膜破裂,无假关节形成,无内固定断裂及松动,矫正度无显著丢失。1 例患者术前骨盆牵引发生钉道感染,经局部换药及抗生素应用,2 周后感染控制;1 例术后第 3 天发生十二指肠系膜上动脉综合征,采取禁食水、持续胃肠减压、维持水电解质平衡、左侧卧位,术后 2 周痊愈;1 例 T4 左侧椎弓根螺钉侵入椎管压迫神经,术后 5h 发生左下肢不完全性瘫痪,术后 8h 去除 T4 左侧椎弓根螺钉,术后 5 个月左下肢功能完全恢复。**结论:**采用后路凸侧椎板楔形截骨经肋椎关节松解胸椎间隙治疗青少年重度脊柱侧后凸畸形,不需要剥离椎体侧方胸膜,手术解剖层次表浅和创伤小,不仅有助于增加脊柱柔韧性,而且可提供足够的压缩和闭合空间来矫正脊柱侧后凸,能获得良好的脊柱三维矫正。

【关键词】 重度脊柱侧后凸;青少年;凸侧椎板楔形截骨;肋椎关节;胸椎间隙松解

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【Abstract】 Objectives: To evaluate the early clinical efficacy and safety of posterior convex lamina wedge osteotomy and thoracic intervertebral disc space release through costovertebral joints for severe and rigid kyphoscoliosis in adolescents. **Methods:** From May 2014 to December 2016, 15 patients with severe rigid kyphoscoliosis were treated with posterior convex lamina wedge osteotomy and thoracic intervertebral space release through costovertebral joints at our hospital, and only one of them underwent halo-pelvic traction before operation. There were 6 males and 9 females, aged 13 to 18 years, with a mean age of 16.1 ± 1.6 years. Among them, 3 patients were of congenital vertebral deformity, 11 were of neglected idiopathic scoliosis, and 1 was of type I neurofibromatosis. The mean preoperative scoliosis Cobb angle was $102.5^\circ\pm 17.6^\circ$ (ranged 82° to 144°). The mean flexibility was $(21.56\pm 5.70)\%$ (range, 6.4% to 28.5%). And the mean preoperative sagittal kyphosis angle was $68.1^\circ\pm 15.3^\circ$ (ranged 50° to 95°). The coronal balance distance(between coronal C7 centroid

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第一作者简介:男(1955-),教授,主任医师,研究方向:脊柱外科

电话:(0558)650143 E-mail:fylichao2008@sina.com

plumb line and the central sacral vertical line) was 2.0 to 6.8cm, with a mean distance of 3.40 ± 1.37 cm. The muscle strength and sensation of extremities of all the patients were normal before operation. **Results:** The average number of wedge osteotomy of convex vertebral lamina was 5.20 ± 0.56 and the release space was 5.20 ± 0.56 . The operative time ranged from 6.1 to 7.9 hours, which was averaged 7.00 ± 0.51 hours. Intraoperative blood loss was 1050ml to 2500ml, with a mean of 1450.0 ± 521.3 ml. The mean postoperative scoliosis Cobb angle was $28.0^\circ\pm6.6^\circ$ (range, 18° to 40°), and the correction rate was 72.5%. The mean postoperative sagittal kyphosis angle was $27.8^\circ\pm6.1^\circ$ (ranged 22° to 42°), and the correction rate was 58.4%. The mean coronal balance was 0.85 ± 0.74 cm(range, 0 to 2cm), and the correction rate was 72.8%. The mean follow up period was 33.1 ± 5.4 months(range, 25 to 41 months). At the most recent follow-up, the scoliosis Cobb angle was $30.0^\circ\pm6.9^\circ$ (range, 19° to 43°), and the correction rate was 70.6%. The sagittal kyphosis angle was $28.6^\circ\pm6.5^\circ$ (range, 22° to 42°), and the correction rate was 57.2%. The mean coronal balance was 1.10 ± 0.72 cm(range, 0.2 to 2.3cm), and the correction rate was 71.3%. No pleural rupture was recognized during surgery. There were no definite pseudarthrosis, no breakage or loosening of internal fixation. Besides, no definite loss of correction was observed at the final follow up. One patient had pelvic traction nail tract infection before operation. After 2 weeks, the infection was controlled after local wound dressing change and antibiotic application. One patient experienced superior mesenteric artery syndrome at the third day postoperatively, which was resolved after 2 weeks by nutilization via nasogastric tube, electrolytic balance and appropriate position. One case developed incomplete paralysis of the left lower limb 5 hours after operation and gradually aggravated. CT examination showed that the left pedicle screw of T4 invaded the spinal canal and compressed the spinal cord. The operation was repeated 8 hours after operation, which removed the left pedicle screw of T4, and the function of the left lower limb recovered completely 5 months after operation. **Conclusions:** Posterior convex lamina wedge osteotomy and thoracic intervertebral disc space release through the costovertebral joints for treating severe and rigid kyphoscoliosis in adolescents does not require that the parietal pleura be detached off the lateral side of the vertebra. There is less deep dissection and trauma is less. The operation not only serves to increase the flexibility of the spine, but also provides enough space for compression and closure to correct the kyphoscoliosis. It can obtain excellent three-dimensional correction of spine.

【Key words】 Severe kyphoscoliosis; Adolescent; Convex lamina wedge osteotomy; Costovertebral joints; Thoracic intervertebral space release

【Author's address】 Department of Orthopedics, Fuyang People's Hospital, Anhui Medical University, Fuyang, 236000, China

重度脊柱侧后凸由于畸形复杂、僵硬,侧后凸角度大,手术困难,并发症发生率高,有挑战性^[1-3]。传统的经胸腔前路松解胸椎间隙及一期或二期后路矫正术,创伤大,对心肺干扰大,手术时间长,给一些心肺功能较差的重度脊柱侧凸患者带来较大风险,甚至丧失手术机会^[4-5]。而采用经后路胸膜外松解脊椎楔形截骨方法由于广泛剥离胸膜易损伤胸膜,易导致血气胸^[6,7]。近年来常用的经椎弓根截骨术或全椎体切除术不仅手术操作复杂,学习曲线陡峭,而且创伤大,风险高^[8,9]。因此,寻找一种安全有效的手术方法至关重要。为此,作者设计了经后路凸侧椎板楔形截骨经肋椎关节松解胸椎间隙矫形治疗重度僵硬性脊柱侧后凸 15 例,报道如下。

1 资料与方法

1.1 一般资料

2014 年 5 月~2016 年 12 月对我院 15 例重度僵硬性脊柱侧后凸患者行经后路凸侧椎板楔形截骨经肋椎关节松解胸椎间隙手术治疗。男 6 例,女 9 例,年龄 13~18 岁(16.1 ± 1.6 岁)。其中先天性脊柱侧后凸 3 例,特发性 11 例,神经纤维瘤病性 1 例。术前侧凸 Cobb 角 $82^\circ\sim144^\circ$ ($102.5^\circ\pm17.6^\circ$),侧凸的柔韧性为 6.4%~28.5%[(21.56 ± 5.70)%],后凸 $50^\circ\sim95^\circ$ ($68.1^\circ\pm15.3^\circ$),顶椎偏移距离 6.4~13.8cm(9.19 ± 2.58 cm),冠状位躯干偏移距离(C7 中垂线与骶骨中垂线距离)2.0~6.8cm (3.40 ± 1.37 cm),矢状位偏移距离为 1.5~4.0cm (2.68 ± 1.00 cm)。术前四肢肌力及感觉均正常。

1.2 手术设计及步骤

全麻,患者俯卧位,后正中入路显露畸形脊柱全段,两侧显露到横突外缘。根据畸形类型及范

围,选择顶椎上下 3~6 个节段椎体两侧分别进行椎弓根螺钉固定。于后正中切口内顶椎区凸侧,沿竖脊肌表面和腰背筋膜下广泛剥离,显露顶椎区凸侧竖脊肌,于竖脊肌外缘分离将竖脊肌牵向内侧,背阔肌及斜方肌牵向外侧,在顶椎区凸侧显露并切除引起剃刀背最明显的 5~6 根肋骨连同肋骨小头,切除肋骨小头时采取经肋横关节切除肋骨小头,显露肋椎关节。

顶椎区凸侧椎板楔形截骨:顶椎区凸侧椎板楔形截骨范围,楔形尖部位于顶椎棘突间隙,底部位于椎体凸侧的上、下关节突(图 1)。用锐利骨刀或超声骨刀在顶椎区椎体凸侧椎板实施楔形截骨,为保证脊髓安全,先用骨刀楔形切开凸侧椎板外板,然后用超薄型椎板咬骨钳由关节突外缘经椎间孔向棘突方向逐步咬除凸侧椎板。

经肋椎关节松解胸椎间隙:切除凸侧肋骨小头(5~8cm)及凸侧上、下关节突显露出椎体后外侧椎间盘及肋椎关节,用骨刀由肋椎关节前缘至椎间孔内缘切除椎体后外侧上、下终板软骨及椎间盘,将椎间铰刀及椎间撑开器插入椎间隙进一步清除终板软骨及椎间盘,并逐渐撑开椎间隙并反复撬动上、下椎体和松解椎间隙,直到椎体间出现明显松动。如上方方法可根据需要松解 5~6 个椎间隙。

顶椎区凹侧肋椎关节松解:本组 3 例经凸侧椎间隙松解后脊柱柔韧性明显改善,未做凹侧肋椎关节松解,其余 12 例均做凹侧肋椎关节松解。用骨凿沿肋椎关节间隙逐渐向深部凿开肋椎关节

间隙,用骨膜剥离器将肋椎关节间隙进一步撬开,使肋骨头与椎体分离松动即可,不必强求切除肋骨头。同时对所有患者凹侧关节突松解。

在凸侧置连接棒并压缩固定,再于凹侧置连接棒,由凸侧向凹侧转棒矫正椎体旋转,并纵向撑开固定。将去除的肋骨制成骨棒植于融合节段椎板上。

1.3 术后处理

所有患者术后禁食 3d,营养支持,抗生素应用 3d,伤口负压引流 24~48h,12~14d 拆线后佩戴脊柱外固定保护支具出院,2 周后佩戴保护支具下床,本组支具保护 6 个月。

1.4 观察指标

记录侧凸柔韧性、手术时间、手术出血量、椎间隙松解范围、椎板楔形截骨数目、松解椎间隙数目、融合节段、随访时间,术前、术后及末次随访侧凸 Cobb 角、胸椎后凸 Cobb 角、顶椎偏移距离、冠状位躯干偏移距离、矢状位偏移距离,并发症。

2 结果

本组仅 1 例侧凸 Cobb 角 144°患者术前进行了 2 个月头盆环牵引,其余患者术前均未接受牵引治疗。15 例患者的性别、年龄、诊断、截骨数目、椎间隙松解情况、凹侧松解情况、融合节段、手术时间、术中出血量及随访时间见表 1。平均椎板楔形截骨 5.2 ± 0.56 个,松解椎间隙 5.2 ± 0.56 个。手术时间 6.1~7.9h(7.00 ± 0.51 h),术中出血量 1050~2500ml(1450.0 ± 521.3 ml)。1 例患者术前骨盆牵引

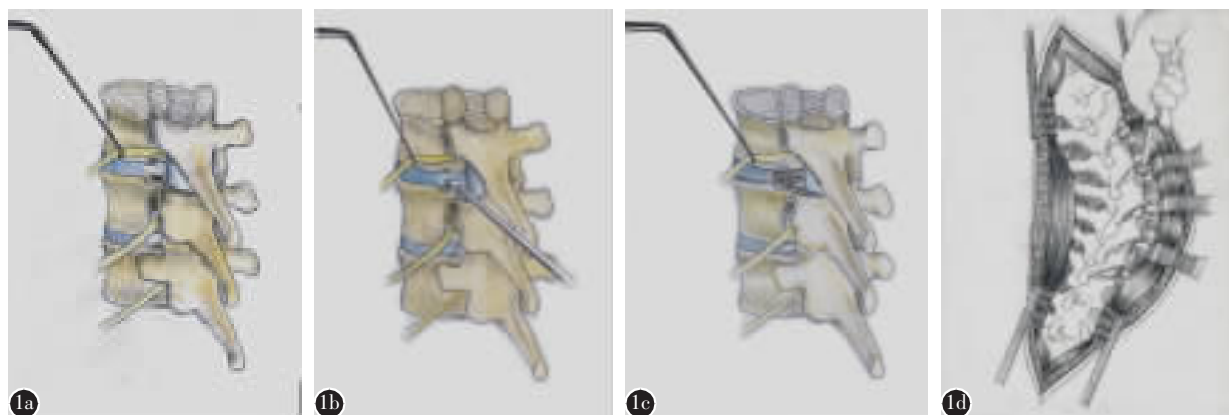


图 1 a 经后路凸侧椎板楔形截骨,肋骨头切除,显露肋椎关节及椎间隙 b 经肋椎关节松解胸椎间隙 c 去除椎间盘及软骨终板 d 整体手术视野

Figure 1 a Convex lamina wedge resection osteotomy and the proximal rib resection were performed to expose the costovertebral joints and intervertebral spaces b Releasing of thoracic intervertebral space through the costovertebral joints c The disc and the cartilaginous end plates were removed d Overview of the surgical field

表 1 15 例患者的一般资料
Table 1 Demographics and clinical data of patients

患者 Patient	性别 Sex	年龄(岁) Age(yrs)	诊断 Dx	截骨数目 Osteotomy No.	椎间隙 松解 ISR levels	凹侧 松解 CCJR	融合节段 FS levels	手术时间 (小时) OR time (h)	出血量 (毫升) OR EBL (ml)	随访时间 (月) Follow-up (mo)
1	F	14	IS	5	T6~T11	Y	T2~L4	7.5	2300	28
2	F	17	IS	4	T6~T10	N	T3~L2	6.7	1050	41
3	M	18	NS	5	T8~L1	Y	T4~L4	7	2400	35
4	M	17	CS	5	T6~T11	Y	T2~L4	7.8	1250	32
5	F	17	CS	6	T3~T9	Y	T1~L4	7.9	2500	27
6	F	15	IS	5	T6~T11	Y	T1~L4	6.8	1750	40
7	F	16	IS	5	T7~T12	Y	T1~L3	6.7	1100	38
8	M	17	IS	5	T5~T10	Y	T2~L3	6.8	1350	39
9	F	18	IS	5	T7~T12	N	T2~L3	6.9	1150	36
10	F	16	IS	5	T6~T11	Y	T3~L5	7.2	1050	30
11	M	18	CS	6	T6~T12	Y	T2~L4	7	1150	36
12	M	17	IS	6	T6~T12	Y	T2~L4	7.4	1100	35
13	F	14	IS	5	T6~T11	Y	T3~L3	6.3	1200	28
14	M	13	IS	5	T7~T12	N	T4~L2	6.1	1150	26
15	F	15	IS	6	T5~T11	Y	T2~L3	6.6	1250	25

注:F,女;M,男;CS,先天性脊柱侧凸;NS,神经纤维瘤病性脊柱侧凸;IS,特发性脊柱侧凸;Y,是;N,否

Note: F, female; M, male; CS, congenital scoliosis; NS, neurofibromatosis scoliosis; IS, idiopathic scoliosis; Dx, diagnosis; ISR, intervertebral space release; OR, operation; EBL, estimated blood loss; FS, fusion segment; CCJR, concave costovertebral joint release; Y, yes; N, no

发生钉道感染,经局部换药及抗生素应用,2 周后感染控制;1 例术后发生十二指肠系膜上动脉综合征,采取禁食水、持续胃肠减压、维持水电解质平衡、左侧卧位,术后 2 周痊愈;1 例术后 5h 发生左下肢不完全性瘫痪,左下肢肌力仅 1 级,CT 检查发现 T4 左侧椎弓根螺钉侵入椎管压迫脊髓,于术后 8h 再次手术,去除 T4 左侧椎弓根螺钉,术后 5 个月左下肢功能完全恢复。无胸膜破裂及气胸发生。

15 例患者的侧凸柔韧性、侧凸 Cobb 角、胸椎后凸 Cobb 角、顶椎偏移距离、冠状位躯干偏移距离及矢状位偏移距离情况见表 2。术后侧凸 Cobb 角 $18^{\circ}\sim 40^{\circ}$ ($28.0^{\circ}\pm 6.6^{\circ}$),矫正率 72.5%;后凸 $22^{\circ}\sim 42^{\circ}$ ($27.8^{\circ}\pm 6.1^{\circ}$),矫正率 58.4%;冠状位躯干偏移距离 $0\sim 2\text{cm}$ ($0.85\pm 0.74\text{cm}$),矫正率 72.8%;顶椎偏移距离 $1.0\sim 4.2\text{cm}$ ($2.24\pm 0.84\text{cm}$),平均矫正率 74.6%;矢状位偏移距离 $0\sim 3\text{cm}$ ($0.94\pm 0.90\text{cm}$),平均矫正率 61.7%。随访 25~41 个月 (33.1 ± 5.4 个月)。末次随访时,侧凸 Cobb 角 $19^{\circ}\sim 43^{\circ}$ ($30.0^{\circ}\pm 6.9^{\circ}$),矫正率 70.6%;后凸 $22^{\circ}\sim 42^{\circ}$ ($28.6^{\circ}\pm 6.5^{\circ}$),矫正率 57.2%;冠状位躯干偏移距离 $0.2\sim 2.3\text{cm}$

($1.10\pm 0.72\text{cm}$),矫正率 71.3%;顶椎偏移距离 $1.2\sim 4.7\text{cm}$ ($2.79\pm 1.26\text{cm}$),平均矫正率 72.3%;矢状位偏移距离 $0\sim 3.4\text{cm}$ ($1.40\pm 1.27\text{cm}$),平均矫正率 60.2%。矫正度无显著丢失,所有患者植骨愈合良好,内固定无断裂及松动(图 2~4)。

3 讨论

3.1 凸侧椎板楔形截骨设计意义

重度脊柱侧凸畸形复杂、僵硬、弯曲角度大。因此,完成重度脊柱侧凸手术矫正必须具备以下三要素:(1)使脊柱获得足够的柔韧性;(2)在脊柱凸侧能获得足够加压闭合矫形的空间;(3)脊柱获得足够的矫正力和固定力。采用传统的经椎弓根截骨术(pedicle subtraction osteotomy,PSO)或后路全椎体切除术(posterior vertebral column resection,PVCR)虽然可以获得有效的矫正技术条件,但需要显露椎体前、中、后三柱,需要完成三柱截骨或 4 级截骨,椎体截骨不仅手术创伤大,学习曲线陡峭,而且导致脊髓神经损伤等重要并发症发生率较高^[10,11]。Suk 等^[12]报告了 PVCR 治疗重度脊柱畸形,术后平均冠状畸形矫正率 61.9%,70

表 2 15 例患者的术前、术后和末次随访时的影像学测量结果

Table 2 Radiographic data of 15 patients at preoperation, postoperation and final follow-up

患者 Pa- tient	柔韧 Flexi- bility (%)	侧凸 Cobb 角(°) Scoliosis			胸椎后凸 Cobb 角(°) Thoracic kyphosis			顶椎偏移距离(cm) Apical vertebral translation			冠状位躯干偏移距离 (cm) Coronal balance distance			矢状位偏移距离(cm) Sagittal balance distance		
		术前 Preop	术后 Postop	随访 F/U	术前 Preop	术后 Postop	随访 F/U	术前 Preop	术后 Postop	随访 F/U	术前 Preop	术后 Postop	随访 F/U	术前 Preop	术后 Postop	随访 F/U
1	14.8	122	23	25	91	23	23	13.8	1.5	1.5	6.8	1.0	1.0	3.0	1.1	1.1
2	20.6	87	18	19	51	22	22	6.9	1.0	1.2	3.0	0.5	0.5	2.0	1.2	1.2
3	19.2	120	32	35	67	25	25	12.8	2.1	2.5	5.2	1.7	1.5	3.2	2.0	3.0
4	6.4	109	30	33	72	25	27	7.0	2.0	2.2	2.8	0.2	0.2	4.0	0	2.5
5	16.7	144	40	43	95	42	42	8.1	4.2	4.5	4.0	0	1.5	4.0	0	3.4
6	18.9	106	22	25	90	28	29	10.8	3.2	4.5	5.3	0.3	2.1	2.0	2.0	1.5
7	20.8	101	29	31	87	37	39	11.5	3.1	4.7	3.5	2.0	2.0	1.5	1.0	0.2
8	22.4	116	31	33	60	22	22	11.1	2.1	4.6	3.0	0	0.2	3.0	3.0	1.0
9	27.3	88	32	33	65	27	29	7.1	2.0	3.4	2.5	2.0	2.3	2.0	0	0
10	25.8	89	22	22	58	24	24	7.3	1.5	1.5	2.0	0	0.6	4.8	0	4.0
11	24.2	95	20	22	62	35	35	7.5	2.0	2.0	2.5	0.5	0.6	3.0	1.0	0.5
12	23.4	107	40	42	60	32	35	12.6	2.5	2.5	2.5	1.7	1.5	2.0	0	0
13	27.8	85	27	29	62	29	30	7.2	2.3	2.3	2.4	1.0	0.5	1.9	1.1	0.6
14	28.5	82	24	27	50	24	25	6.4	1.2	1.5	2.2	0.5	0.4	1.4	0.5	0.5
15	26.6	87	30	31	52	22	22	7.7	2.9	2.9	3.1	1.3	1.6	2.6	1.3	1.5

Note: Preop, preoperation; Postop, postoperation; F/U, follow-up

例患者中有 24 例(34.2%)出现并发症,其中完全性脊髓损伤 2 例,血肿 6 例,内固定失败 5 例,感染 2 例,术后血气胸 5 例,不完全性神经根损伤 4 例。Lenke 等^[13]通过 PVCR 治疗 147 例儿童重度脊柱畸形,并发症发生率 59%。Chang 等^[14]对通过 PVCR 治疗 18 岁以下的 45 例先天性脊柱侧凸(随访 10 年以上)进行统计分析,并发症发生率为 48.9%。Iyer 等^[15]总结了成人脊柱僵硬性畸形 VCR 术后并发症和治疗结果,VCR 术后冠状面矫正率为 54%~67.2%,矢状位矫正率为 60%~90.9%,总的并发症发生率为 69.2%,主要并发症的发生率为 27.7%,神经并发症的发生率为 13.3%。尽管 PVCR 是矫正重度脊柱畸形的有效方法,但是其本身具有创伤大、并发症发生率高^[3,8,9]。Chan 等^[16]认为 VCR 技术要求很高,无论术中经验多么丰富,手术风险都很高。Lee 等^[2]报道,尽管 PVCR 能有效矫正严重脊柱畸形,但 PVCR 手术操作困难,是一项要求非常严格的手术,手术相关的严重并发症比较常见,并发症发生率高达 55.9%,35.3%病例需要再次手术,因此,强调 PVCR 技术应被限制使用。传统 Ponte 截骨技术虽然简单,但对增加脊柱柔韧性的作用受到质疑^[17]。Halanski 等^[18]的研究表明,与单纯的下关节突切除相比,

Ponte 截骨并没有显著增加青少年特发性脊柱侧凸(adolescent idiopathic scoliosis, AIS)的矫形率。

我们设计的后路凸侧椎板楔形截骨同属于后柱截骨,虽然对改善脊柱柔韧性有限,但通过顶椎区凸侧多个椎板楔形截骨,切除凸侧多根肋骨和经肋椎关节切除多个节段胸椎间盘,能获得较好的柔韧性。此方法截骨及松解部位表浅,不需要剥离胸膜显露脊柱前柱和中柱,更不需要处理复杂的椎体后缘,操作简单,创伤小,并发症低。本组平均椎板楔形截骨 5.2 个,松解椎间隙 5.2 个,手术时间平均 7.0h,术中出血量平均 1450ml,侧凸矫正率 72.5%,无截骨造成的神经损伤等主要并发症。后路凸侧椎板楔形截骨不仅在脊柱凸侧能获得足够加压闭合矫形的空间,改善脊柱柔韧性,而且能充分显露凸侧椎体后外侧椎间隙,连同肋椎关节的显露,为显露和切除椎体后外侧椎间盘、松解胸椎间隙提供了显露和操作空间。

3.2 经肋椎关节松解椎间隙优势

以往采用传统的经胸腔前路松解胸椎间隙及一期或二期后路矫正术,创伤大,对心肺干扰大,目前已摒弃。目前多采用经后路胸膜外松解胸椎间隙的方法^[6]。但此方法需要广泛剥离胸膜显露椎体侧前方才能切除胸椎间盘和松解椎间隙。由

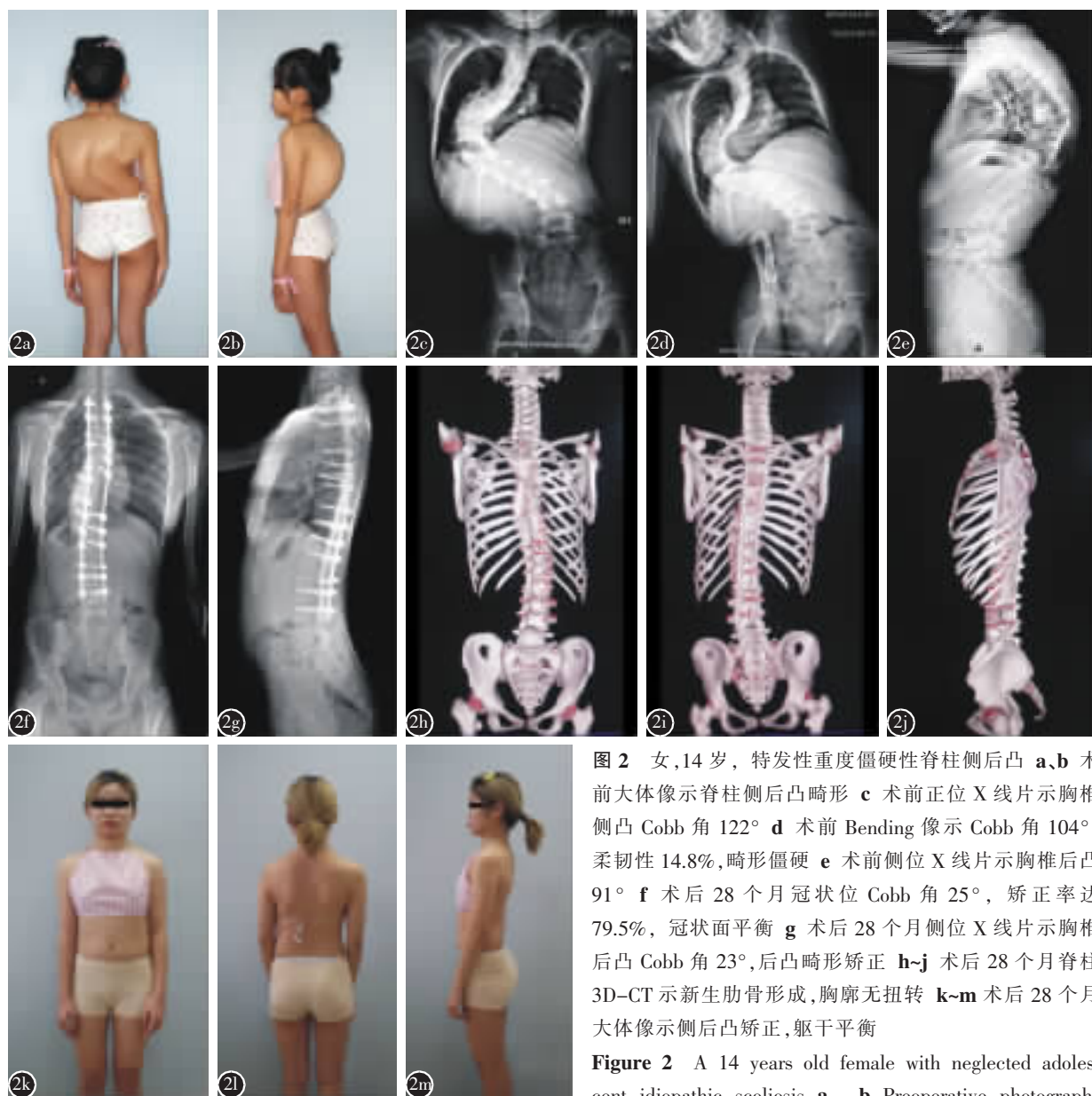


图2 女,14岁,特发性重度僵硬性脊柱侧后凸 a、b 术前大体像示脊柱侧后凸畸形 c 术前正位X线片示胸椎侧凸 Cobb角 122° d 术前Bending像示Cobb角 104° ,柔韧性14.8%,畸形僵硬 e 术前侧位X线片示胸椎后凸 91° f 术后28个月冠状位Cobb角 25° ,矫正率达79.5%,冠状面平衡 g 术后28个月侧位X线片示胸椎后凸Cobb角 23° ,后凸畸形矫正 h~j 术后28个月脊柱3D-CT示新生肋骨形成,胸廓无扭转 k~m 术后28个月大体像示侧后凸矫正,躯干平衡

Figure 2 A 14 years old female with neglected adolescent idiopathic scoliosis a, b Preoperative photographs

showed kyphoscoliosis deformity c Preoperative coronal Cobb angle was 122° d Bending radiograph Cobb angle was 104° , flexibility 14.8% e Preoperative thoracic kyphosis was 91° f Coronal Cobb angle was 25° at 28 months after operation, correction rate of 79.5%. the trunk appears balanced g Thoracic kyphosis was 23° at 28 months after operation h~j 3D-CT of spine 28 months after operation showed new rib formation and no thoracic torsion k~m The postoperative photographs showed good trunk balance and kyphoscoliosis showed good correction 28 months after the operation

于广泛剥离胸膜容易损伤胸膜,造成血气胸,术后胸腔引流不仅给患者带来较大痛苦,而且给术后管理带来较多困难,甚至需要延长住院时间。经肋椎关节松解胸椎间隙,不需要另加或设计特定切口,利用切除凸侧剃刀背畸形的肋骨即可显露多个肋椎关节。由于重度脊柱侧凸顶椎区椎体多向凸侧的侧后方旋转,使凸侧肋骨小头切除及肋椎关节显露更为方便。肋椎关节前缘至后缘的距离

大约10~12mm大小,由于凸侧椎板楔形截骨同时切除上、下关节突,如同MIS-TILF术式,使凸侧椎体后外侧椎间盘清晰显露,由椎间孔内缘延续到肋椎关节前缘,在椎体后外缘形成约15~20mm长度的椎间盘裸露区,为切除椎间盘松解椎间隙提供了充足的空间。由于经肋椎关节松解椎间隙不需要剥离胸膜,不易损伤胸膜,不仅可避免血气胸发生,而且创伤小,降低了手术风险。本组未发



图3 男,18岁,神经纤维瘤病脊柱侧后凸 a~c 术前大体像显示皮肤有较多咖啡色斑点 d 术前正位X线片示胸椎侧凸 Cobb角 120° e 术前 Bending 像显示 Cobb角 97° , 柔韧性 19.2% , 畸形僵硬 f 术前侧位X线片示胸椎后凸 67° g 术后35个月正位X线片示侧凸 Cobb角 35° , 矫正率

为 70.8% , 冠状面平衡 h 术后35个月侧位X线片示胸椎后凸 Cobb角 25° , 后凸畸形矫正 i~k 术后35个月脊柱3D-CT显示新生肋骨形成, 胸廓无扭转 l~n 术后35个月大体像侧后凸矫正, 躯干平衡

Figure 3 male patient, 18 years old presenting with severe rigid scoliosis due to an neurofibromatosis scoliosis a~c Preoperative photographs showed spinal scoliosis and there was more coffee spots on the skin d Preoperative coronal Cobb angle was 120° e Bending radiograph Cobb angle was 97° , and flexibility was 19.2% f Preoperative thoracic kyphosis was 67° g Postoperative coronal Cobb angle was 35° at 35 months after operation, with a correction rate of 70.8% and resulted in a balanced coronal plane h Thoracic kyphosis was 25° at 35 months after operation i~k 3D-CT of spine 35 months after operation showed new rib formation and no thoracic torsion l~n The postoperative photographs showed good trunk balance and kyphoscoliosis showed good correction 35 months after the operation

生血气胸。

3.3 顶椎区肋骨切除意义

Halsall 等^[19]在张力侧切除肋骨之前和之后测试了尸体中脊柱的柔韧性, 并发现偏转平均增加了 53% 。Halanski 等^[18]的研究表明, 肋骨头切除后

脊柱屈曲活动度增加 6.3% , 侧屈增加 4.5% , 轴向旋转增加 13.0% 。Hempfling 等^[20]认为, 采取凹侧肋骨切除与松解的方法可使脊柱获得较好的柔韧性。临床上凹侧肋骨切除或松解术治疗僵硬性侧凸的有效性支持这些发现^[21-24]。作者采取凸侧椎

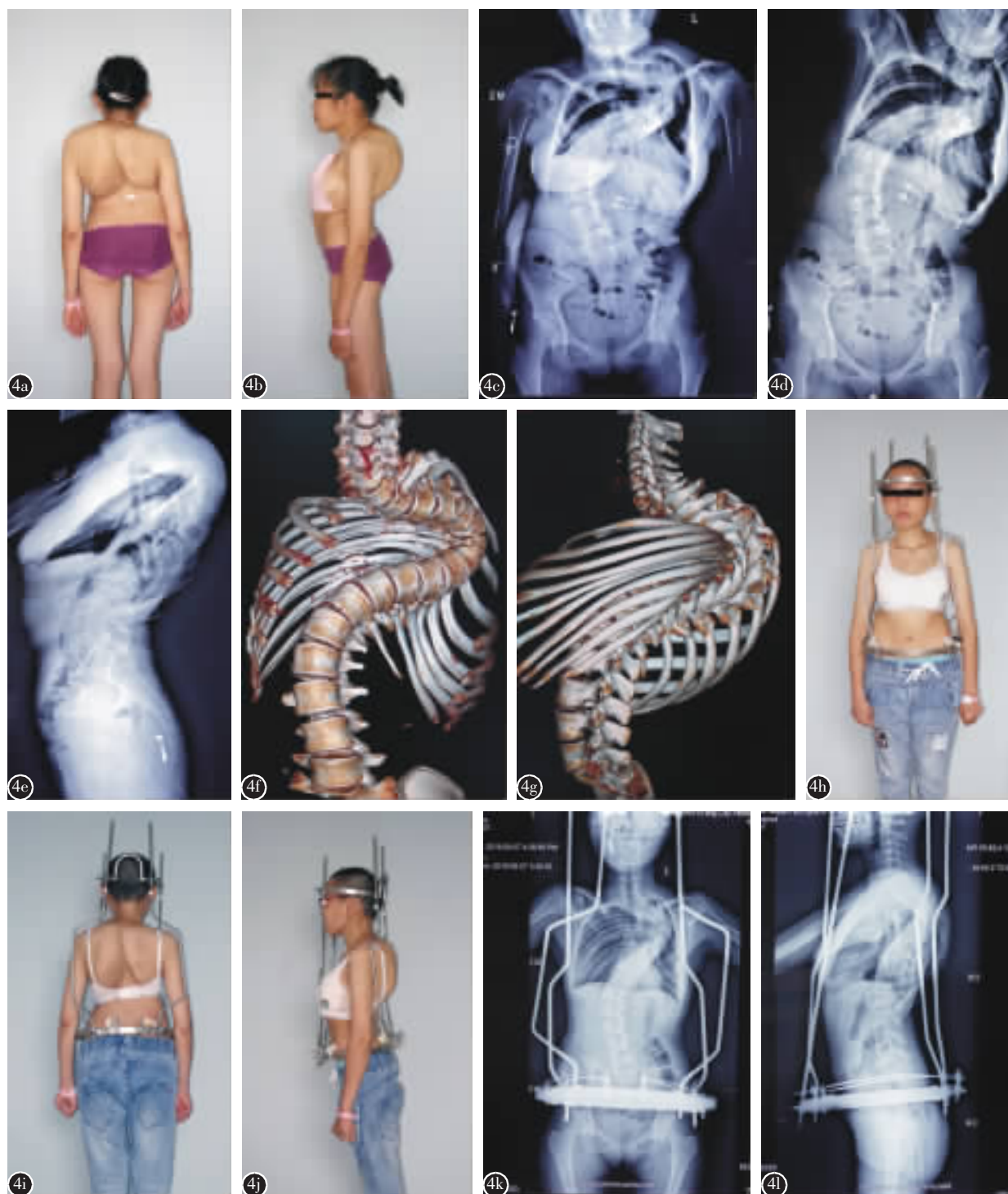


图 4 女, 17 岁, 先天性脊柱侧后凸 a、b 术前大体像脊柱侧后凸畸形 c 术前正位 X 线片示冠状 Cobb 角 144° d 术前 Bending 像显示 Cobb 角 120° , 柔韧性 16.7% e 术前胸椎后凸 95° f、g 术前脊柱 3D-CT 脊柱严重侧后凸畸形 h~j 术前头盆环牵引大体像 k、l 头盆环牵引 2 个月后正位 X 线片示冠状 Cobb 角 87° , 侧位 X 线片示胸椎后凸 71°

Figure 4 female patient, 17 years old presenting with severe rigid scoliosis due to an congenital scoliosis a, b Preoperative photographs showed spinal kyphoscoliosis c Preoperative coronal Cobb angle was 144° d Bending radiograph Cobb angle was 120° , and flexibility was 16.7% e Preoperative thoracic kyphosis was 95° f, g Preoperative spinal 3D-CT showed severe kyphoscoliosis of spine h~j Preoperative photographs using Halopelvic traction for 2 months k, l The coronal Cobb angle was 87° and the thoracic kyphosis was 71° after 2 months of halopelvic traction

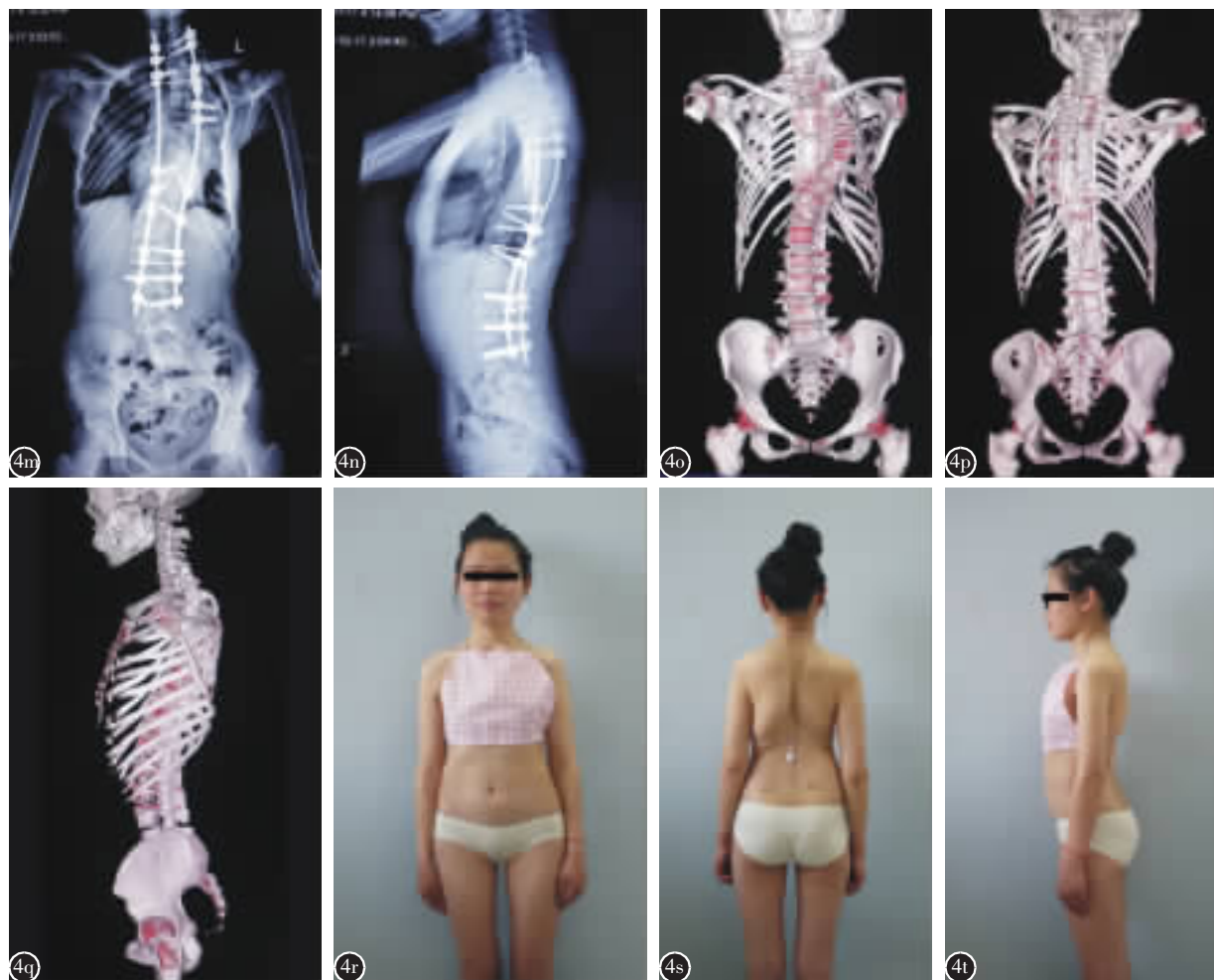


图 4 m 术后 27 个月正位 X 线片示 Cobb 角 43° , 矫正率 70.1%, 冠状面平衡 n 术后 27 个月侧位 X 线片示胸椎后凸 42°
o~q 术后 27 个月脊柱 3D-CT 显示新生肋骨形成, 胸廓无扭转 r~t 术后 27 个月大体像侧后凸矫正, 躯干平衡

Figure 4 m Postoperative coronal Cobb angle was 43° at 27 months after operation, with a correction rate of 70.1% and resulted in a balanced coronal plane n Post-operative thoracic kyphosis was 42° at 27 months after operation o~q 3D-CT of spine 27 months after operation showed new rib formation and no thoracic torsion r~t The postoperative photographs showed good trunk balance and kyphoscoliosis showed good correction 27 months after the operation

板楔形截骨, 切除凸侧剃刀背畸形的肋骨, 经肋椎关节松解椎间隙的基础上, 对顶椎区凹侧施行肋椎关节松解方法, 解除了凹侧紧缩带对脊柱牵拉, 改善了脊柱柔韧性, 为矫正脊柱畸形提供了有利条件, 本组无严重并发症, 术后侧凸矫正率达 72.5%。为保证手术安全性, 作者强调松解凹侧肋椎关节时, 因为肋骨头位置深凹, 切除肋骨头较为困难, 建议采用骨凿凿开并旋转撬开肋椎关节间隙, 使之松动即可。不必强求切除肋骨头, 否则易损伤胸膜。本组虽然切除凸侧 5~6 根肋骨, 但肋骨切除长度仅 5~8cm, 其余多数完整肋骨仍能对胸廓起到支撑固定作用, 加之脊柱钉棒内固定支撑, 本组病例术中切除肋骨时骨膜保留完整, 术后

随访胸廓三维 CT 重建显示在切除肋骨部位由于骨膜膜内骨化形成新生肋骨, 使胸廓稳定性得到重建, 术后不易发生胸廓扭转 (见图 2~4 术后随访胸廓 3D-CT)。

为防止断钉、断棒等并发症, 我们强调椎板植骨床去骨皮质化和充分植骨, 术后佩戴胸腰骶外固定支具保护长达 6 个月, 以提高脊柱融合率。

综上所述, 青少年重度僵硬性脊柱侧凸与成人重度僵硬性脊柱侧凸相比, 虽同属于重度僵硬性脊柱侧凸, 但青少年重度僵硬性脊柱侧凸具有潜在的柔韧性, 不需要三柱截骨, 经后路凸侧椎板楔形截骨与经肋椎关节松解椎间隙能获得较好的脊柱柔韧性与脊柱畸形矫正。本组手术创伤较椎

体截骨小,不需要剥离胸膜,手术风险小,并发症发生率低。在治疗青少年重度脊柱侧凸方面可以获得与椎体截骨术同样的效果。本组病例较少,随访时间较短,疗效有待进一步观察。

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(英文编审 谭 啸)

(本文编辑 李伟霞)