

临床论著

一期前后路联合手术治疗儿童活动性胸腰椎结核的中长期临床疗效

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【摘要】目的:探讨应用一期后路椎弓根螺钉内固定融合联合前路病灶清除、同种异体骨重建术治疗儿童活动性脊柱结核的中、长期效果。**方法:**回顾性分析我院 2008 年 1 月~2013 年 1 月共 19 例采用一期后路椎弓根螺钉内固定融合联合前路病灶清除、同种异体骨支撑重建的术式治疗胸、腰椎结核感染导致至少连续两个椎体破坏的患儿资料, 年龄 3~10 岁, 平均 6.3 ± 2.1 岁, 随访时间 5~11 年, 平均 7.5 ± 2.0 年, 受累椎体 2~4 个。所有患儿分别于术后 1 周、3、6、12 个月行 X 线检查, 随后每年行 X 线检查一次, 测量后凸 Cobb 角, 同时观察有无植骨块移位、松动、塌陷以及有无后凸畸形发生, 记录患儿术前、术后 1 周及每次复查时的 Frankel 分级、后凸角、红细胞沉降率(ESR)、C-反应蛋白(CRP), 对于随访超过 5 年的患儿(19 例)行高分辨率三维 CT 扫描通过 Bridwell 分级评估植骨块融合情况。**结果:**随访期间均未发现结核复发, 未发现钉棒松动、断裂, 术后 6 个月 ESR、CRP 与术前相比均有明显统计学差异($P<0.05$)。术前 Frankel 神经功能分级: B 级 2 例, C 级 5 例, D 级 9 例, E 级 3 例, 术后 1 周时 Frankel 分级: B 级 1 例, C 级 3 例, D 级 1 例, E 级 14 例, 末次随访时 D 级 1 例(术前 B 级), E 级 18 例, 术后 1 周及末次随访与术前相比有统计学差异($P<0.05$)。术前后凸角平均 $41.32^\circ\pm 13.19^\circ$, 术后即刻后凸角度平均 $9.74^\circ\pm 5.80^\circ$, 即刻矫正率 76.4%, 末次随访后凸角平均 $12.32^\circ\pm 6.40^\circ$, 平均丢失 $2.58^\circ\pm 0.60^\circ$, 末次随访时矫正度数为 $29.0^\circ\pm 8.9^\circ$, 矫正率为 70.1%, 术后即刻后凸角与术前相比有统计学差异($P<0.05$), 末次随访后凸角与术后即刻相比, 无统计学差异($P>0.05$)。19 例患儿植入的同种异体骨的上下两端及后方的附件均与周围骨形成骨性连接, Bridwell 分级 1 级融合; 2 例发生骨块下端轻度塌陷但形成骨痂且有骨小梁通过植骨接触面并且无明显植骨块松动及移位, 1 例出现局部轻度后凸畸形, 但无神经损害及局部疼痛。**结论:**一期后路椎弓根螺钉内固定融合联合前路病灶清除、同种异体骨重建的方法治疗儿童胸腰椎结核导致的椎体破坏是一种安全可行的术式, 中、远期随访观察获得了满意的临床结果。

【关键词】 活动性胸腰椎结核; 儿童; 椎体破坏; 椎弓根螺钉; 同种异体大块骨块; 中长期随访

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【Abstract】Objectives: To observe the mid-or long-term efficacy of posterior pedicle-screw fixation and fusion combined with anterior debridement and reconstruction with allograft bone strut in the treatment of pediatric active thoracic and lumbar tuberculosis. **Methods:** Retrospectively reviewed data of 19 pediatric patients (aged 3-10 years, mean age 6.3 ± 2.1 years) with spinal active tuberculosis infection which resulted in at least two consecutive vertebral destruction treated in our hospital from January 2008 to January 2013. All patients underwent one-stage posterior pedicle-screw fixation and fusion combined with anterior debridement and reconstruction of spinal stability with allograft bone strut. The duration of follow-up ranged from 5 to 11 years, averaged 7.5 ± 2.0 years, and the affected vertebral bodies ranged from 2 to 4. All patients were examined clinically and radiologically at 1 week, 3, 6 and 12 months after surgery and received X-ray examination

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once per 12 months to measure the Cobb angle and observe displacement, loosening, collapse of allograft bone, and any kyphotic deformity. The Cobb angle, Frankel grade, ESR and CRP before and one-week after surgery and at every reexamination of each patient were also collected and compared. All 19 patients were followed up more than 5 years, and underwent high resolution 3-D CT scan to evaluate the fusion of bone grafts. **Results:** During the following up, no recurrence of tuberculosis or instrumentation failure occurred. ESR and CRP at 6 months after operation were significantly different from those before surgery ($P<0.05$). The Frankel classification grading before surgery was: 2 cases of Grade B, 5 cases of Grade C, 9 cases of Grade D and 3 cases of Grade E; 1-week after: 1 case of Grade B, 3 cases of Grade C, 1 cases of Grade D and 14 cases of Grade E; and at final follow-up: 1 cases of Grade D (of Grade B before surgery) and 18 cases of Grade E. According to the Frankel motor score system, neurological deficits were improved at one week after surgery (an average improvement of 0.80 grades) and at final follow-up (an average improvement of 1.26 grades) than before surgery, and the differences were of statistical significance($P<0.05$). The average kyphotic angle was changed significantly from a preoperative value of $41.32^{\circ}\pm 13.19^{\circ}$ to a immediate postoperative value of $9.74^{\circ}\pm 5.80^{\circ}$ and, with an average correction rate of 76.4%($P<0.05$). The average kyphotic angle at final follow-up was $12.32^{\circ}\pm 6.40^{\circ}$, with an average loss of $2.58^{\circ}\pm 0.60^{\circ}$. The stable kyphosis correction was $29.0^{\circ}\pm 8.9^{\circ}$, with an correction rate of 70.1%, and there was no significant difference in the Cobb angle between final follow-up and immediate postoperative values($P>0.05$). All 19 patients gained solid fusion at both upper and lower ends of allograft bone strut, achieving Bridwell grade 1 fusion. The lower end of grafts of 2 cases out of the 19 slightly subsided, but osteophyte formed and there were trabeculae through the contact surface with no obvious loosening and dislocation of bone grafts; 1 case exhibited slight local kyphosis, with no neurological deficit and clinical symptoms. **Conclusions:** It is effective, practical and safe to treat vertebral destruction caused by pediatric thoracic and lumbar spinal active tuberculosis by posterior pedicle-screw fixation and fusion combined with anterior debridement and spinal stability reconstruction with allograft bone strut, and in our study, satisfactory clinical results were obtained after mid-term and long-term follow-up.

[Key words] Active pediatric spinal tuberculosis; Vertebral body destruction; Pedicle-screw fixation; Allograft bone strut; Mid- or long-term follow up

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结核感染是一个非常古老的疾病,虽然随着抗结核药物的开发,其发病率一度有所下降,但在过去的数年间,随着获得性免疫缺陷综合征的流行,结核有死灰复燃的趋势^[1],骨结核占有所有结核的 1%~2%,其中脊柱是最常见的受累部位,约占所有骨关节结核的 50%^[2-4]。儿童脊柱由于其终板血管及淋巴管的存在,加上儿童椎前筋膜及骨膜与椎体相连疏松,脊柱结核容易在不同节段间传播,易于在潜在腔隙扩散。所以与成人相比,儿童脊柱结核累及节段常较多^[4,5],更容易导致椎体的大量破坏、椎旁脓肿形成,椎体破坏后可引起局部后凸、侧凸和侧后凸畸形,加之儿童脊柱尚在生长发育阶段,畸形通常会随着生长发育进行性加重,从而导致神经损害进行性加重。在已治愈的儿童脊柱结核中,伴随着生长发育,约 39%的患儿后凸仍会进一步加重,约 3%的儿童脊柱结核的后凸畸形会超过 60°^[6,7],严重后凸可能会导致患儿

心肺功能异常、迟发性下肢瘫痪等严重的远期并发症^[7,8],因此修复、重建被破坏的前中柱并且预防远期后凸畸形的发生非常重要,而修复、重建前中柱至今仍存在不小的困难和挑战,主要原因有:(1)缺乏合适的重建材料,由于儿童髂骨主要为软骨,无法像成人髂骨一样可作为供骨区取骨用于修复椎体缺损;用于成人椎体重建的钛网对儿童来说也不适合,因为儿童骨质较软易被钛网锐利的齿缘切割导致钛网下沉、内陷、甚至移位,远期形成后凸畸形;(2)儿童脊柱拥有生长潜能,目前应用的任何支撑重建材料都不具有生长的潜能,而病椎对应的后柱(主要包括上、下关节突和椎板)仍会继续正常生长继而导致病变节段脊柱的后柱高于前柱而出现进行性加重的后凸畸形^[9,10]。因此,如何消除以上不利因素,既能重建前中柱又能防止远期出现明显后凸畸形而引起神经损伤加重,需要进一步研究。本研究对于近十余年来累及

至少连续两个椎体的儿童胸腰椎结核采用一期后路椎弓根螺钉内固定融合联合前路病灶彻底清除,使用同种异体骨支撑重建的术式进行治疗,并进行了中长期随访,总结如下。

1 资料与方法

1.1 纳入、排除标准

纳入标准:(1)明确诊断胸腰椎活动性结核;(2)年龄 3~10 岁;(3)至少两个椎体受累且有明显的脓肿形成;(4)在我院行一期后路椎弓根钉内固定融合联合前路病灶清除、同种异体骨重建;(5)随访时间 ≥ 5 年;(6)有完整的临床及影像学资料,包括术前、术后、末次随访的站立位 X 线片及神经功能评估记录。

排除标准:(1)跳跃性脊柱结核;(2)既往行脊柱相关手术;(3)单纯后方附件受累。

活动性脊柱结核的诊断标准:(1)典型临床表现,体重下降、低热、盗汗、乏力、窦道形成等;(2)实验室检查:较正常值升高的红细胞沉降率(erythrocyte sedimentation rate, ESR)与 C-反应蛋白(C-reactive protein, CRP);(3)影像学表现,死骨片、脓肿的形成,受累椎体信号的改变,甚至形成明显的椎旁脓肿或腰大肌脓肿;(4)术后病灶组织病原学检查[抗酸染色、培养、聚合酶链式反应(polymerase chain reaction, PCR)]或病理检测明确结核感染。

1.2 一般资料

2008 年 1 月~2013 年 1 月,本研究共 19 例符合纳入标准(详细资料见表 1)。其中男 12 例、女 7 例,年龄 3~10 岁,平均 6.3 ± 2.1 岁。病灶累及部位的分布情况为:6 例在胸椎(T4~T11),8 例在胸腰段(T11~L1),5 例在腰椎(L1~L4)。既往患儿均无明确的肺结核病史,就诊的首要原因为局部疼痛或外观畸形,活动时疼痛加重,14 例患儿盗汗、消瘦等临床症状明显,5 例无典型临床症状,术前依据 Frankel 评分系统评估患者的神经损害情况,B 级 2 例,C 级 5 例,D 级 9 例,E 级 3 例。ESR 为 $37 \sim 81$ mm/h,平均 55.53 ± 11.63 mm/h。CRP 为 $29 \sim 77$ mg/L,平均 50.32 ± 13.50 mg/L。结核菌素实验(purified protein derivative, PPD)、IgG、IgM 特异性抗体均强阳性。胸片或肺部 CT 未发现活动性肺结核。脊柱 CT 发现受累部位明显骨质破坏,局部后凸或错位,MRI 发现椎前或椎旁脓肿形成,

且椎体及椎间盘破坏严重,椎体呈炎性改变。

1.3 手术指征

规范的非手术治疗 ≥ 4 周治疗效果不明显或无效甚至病情加重,出现大量脓肿、死骨、脓肿进入椎管,压迫脊髓造成不同程度的神经功能障碍,神经功能障碍进行性加重,存在严重的后凸畸形或后凸畸形进展可能性大,脊柱明显不稳。

1.4 术前准备

手术前服用抗结核药物 4~6 周,联用的抗结核药物:异烟肼(H, 10mg/kg/d)、利福平(R, 10mg/kg/d)、乙胺丁醇(E, 15mg/kg/d)、吡嗪酰胺(Z, 30mg/kg/d),术前体温正常,术前复查血常规,白细胞正常范围内,CRP 正常范围内,ESR 较药物治疗前明显下降,肝肾功能正常范围内。

1.5 手术方法

气管插管、全麻下取俯卧位,取后正中纵向切口、以病椎为中心向上下延伸切口显露两端各 2 个正常椎体,沿骨膜下剥离椎旁软组织,显露解剖标志,然后根据患儿的年龄和术前站立位胸腰椎 X 线片测量的椎弓根左右径的大小选用直径合适的螺钉(10 例椎弓根直径 < 4.5 mm 的选用成人颈椎侧块螺钉,9 例 > 4.5 mm 的选用较小的成人胸椎椎弓根螺钉)。椎弓根螺钉置入完毕后,对病椎及其相邻上下椎体的小关节适当切除松解以便纠正后凸畸形或脱位。将预弯成与手术部位脊柱生理曲度一致的连接棒放入螺钉尾端的 U 形槽内用螺母将钉棒锁紧。将固定区域内的椎板去皮质骨露出松质骨制造植骨床,然后植入足量的同种异体松质骨条,放置引流管关闭切口。然后重新摆体位,胸椎和胸腰段病变取侧卧位、腰椎病变取斜仰卧位(一般取左侧入路,若右侧脓肿较大,则取右侧入路),经胸膜外或腹膜后入路显露病变椎体、将椎体的节段血管分离结扎、切断,彻底清除椎旁脓肿,切除病变的椎体和椎间盘至两端正常的椎体。准确测量骨质缺损的长度和宽度,将具有三面皮质的大块同种异体骨修剪至合适的尺寸,然后用嵌骨器轻轻敲击使骨块嵌入病灶区的骨质缺损处,尽量使骨块端与椎体充分接触,C 型臂 X 线机透视确定骨块位置良好。清洗伤口,放置伤口引流管,逐层缝合伤口。经腹膜后入路手术的患儿手术后需禁食 2~3d,禁食期间的抗结核药物静脉用异烟肼,待肠道功能恢复可以进食后延续术前抗结核药物治疗方案(6HREZ/6HRE),药物治疗期

间,每月抽血化验血常规、ESR、肝肾功能一次。引流管拔除的时间依据引流量的多少而定,一般 24h 引流量少于 30ml 可以拔除。术后 6~8 周后允许患儿佩戴支具下床活动,佩戴支具时间不少于 3 个月。

1.6 随访及评价方法

所有患儿分别于术后 1 周、3、6、12 个月行 X 线检查,随后每年行 X 线检查一次观察有无植骨块移位、松动、塌陷、以及有无后凸畸形发生;对于随访超过 5 年的患儿行高分辨率三维 CT 扫描一次以最终确认植骨块融合情况,记录患儿术前及末次随访时的 Frankel 神经功能分级,记录患者术前、术后 1 周、末次随访后凸角,记录术前及术后 6 个月时的 ESR 及 CRP 值。后凸角测量方法:紧邻病灶上端正常椎体上终板平行线与紧邻病灶下端正常椎体下终板平行线的夹角^[11],依据 Bridwell 分级系统评植骨融合情况^[12]。前方融合的评价标准:1 级,重塑且有骨小梁通过植骨接触面;2 级,骨接触,尚未完全重塑及骨小梁通过,但骨接触端无透光;3 级,骨接触,但上端或下端骨

接触区有明确的透光区域;4 级,植骨吸收,塌陷,未融合。后方融合的评价标准:1 级,坚固的骨小梁通过双侧关节和横突;2 级,一侧有粗大的骨痂,而另一侧无粗大的骨痂;3 级,在融合的骨痂里可疑有裂隙;4 级,植骨吸收,内固定失败。典型病例见图 1、2。

1.7 统计学处理

所有数据均采用 SPSS 18.0 统计软件进行统计学处理。数据以均值±标准差表示,使用 Wilcoxon 符号秩检验统计分析患者术前与末次随访的 Frankel 分级,术前、术后、末次随访时的后凸角测量结果对比采用配对 *t* 检验,术前与术后 6 个月 ESR、CRP 采用配对 *t* 检验,以 *P*<0.05 为差异有统计学意义。

2 结果

19 例患儿术后病检或培养均明确诊断为胸腰椎活动性脊柱结核,手术时间 245~360min,平均 305.26±35.37min,手术失血量 240~440ml,平均 332.11±53.83ml,住院日 12~26d,平均 16.8±3.3d,

表 1 19 例儿童脊柱结核的一般资料、影像学资料及随访数据

Figure 1 General information, imaging data and follow-up data of 19 children with spinal tuberculosis

病例 编号 Case NO	年龄 (岁) Age	性别 Sexu- al	感染 节段 Infec- tion level	随访时 间(年) Follow up(y)	后凸角(°) Kyphosis angle			Frankel 分级 Frankel grade			血沉(mm/h) ESR		C反应蛋白(mg/L) CRP	
					术前 Pre- op	术后 1 周 Post 1 week	末次 随访 LFU	术前 Pre- op	术后 1 周 Post 1 week	末次 随访 LFU	术前 Pre- op	术后 6 个月 Post 6 month	术前 Pre- op	术后 6 个月 Post 6 month
1	5	M	T5-6	6	54	16	19	C	E	E	62	19	45	8
2	7	M	L2-3	8	28	5	7	D	E	E	39	14	51	9
3	4	F	T12-L1	11	31	5	7	B	C	D	54	11	47	3
4	9	M	T12-L1	9	45	7	10	D	E	E	65	29	77	14
5	6	F	T7-8	8	60	19	20	C	E	E	81	24	59	6
6	7	M	L2-3	7	14	1	5	E	E	E	60	14	41	9
7	8	F	T11-L1	5	47	9	13	D	D	E	55	17	49	11
8	3	M	T4-6	5	61	18	21	C	C	E	62	28	70	9
9	5	F	T12-L1	5	37	4	6	E	E	E	66	22	39	5
10	10	M	T8-9	7	55	17	25	D	E	E	71	19	59	10
11	3	F	L1-3	6	30	2	3	B	B	E	59	16	61	4
12	7	M	T12-L1	10	41	10	14	D	E	E	37	14	41	9
13	6	M	T11-L1	11	46	7	11	D	E	E	45	20	38	7
14	4	M	L2-4	9	35	11	11	D	E	E	49	13	29	7
15	8	F	T9-10	9	45	17	20	C	C	E	51	18	61	11
16	5	M	T8-9	7	46	16	17	D	E	E	47	18	33	6
17	7	M	L2-3	6	22	6	6	E	E	E	37	14	41	5
18	6	F	T12-L1	5	31	5	7	C	E	E	60	21	71	7
19	10	M	T11-L1	8	57	10	12	D	E	E	55	17	44	10

3例患儿术中胸膜破裂,缝线修补,术后未出现胸腔积液等并发症,2例患儿在住院期间浅表伤口愈合不良,床旁加强换药后自行愈合,1例患儿术后感染金黄色葡萄球菌性肺炎,抗生素治疗后痊愈,所有患儿术后临床症状均有明显好转,白细胞计数、ESR、CRP 均在术后 6 个月之内大幅下降或恢复正常水平。术后 6 个月 ESR 值 $18.32 \pm 4.89 \text{ mm/h}$, 术后 6 个月 CRP 值 $7.89 \pm 2.75 \text{ mg/L}$, ESR、CRP 均在术后 6 个月之内大幅下降,与术前相比有统计学差异($P < 0.05$)。随访 1 年时所有患儿白细胞计数、ESR、CRP 均恢复至正常水平,予以停药。随访时间 5~11 年、平均 7.5 ± 2.0 年,随访

期间均未发现结核复发,未发现钉棒断裂,所有患儿术后未见神经功能损害加重。术后 1 周较术前平均提高 0.80 级,末次随访较术前平均提高 1.26 级,术后一周与术前相比有统计学差异($P < 0.05$),末次随访与术前相比有统计学差异($P < 0.05$),术前后凸角平均 $41.32^\circ \pm 13.19^\circ$,术后即刻后凸角度平均 $9.74^\circ \pm 5.80^\circ$,即刻矫正率 76.4%,末次随访后凸角平均 $12.32^\circ \pm 6.40^\circ$,平均丢失 $2.58^\circ \pm 0.60^\circ$,末次随访矫正率 70.1%,术后即刻后凸角与术前相比有统计学差异($P < 0.05$),末次随访后凸角与术后即刻相比,无统计学差异($P > 0.05$);19 例植入的大块同种异体骨的上下两端均与接触的椎体之



图 1 患儿女性,6岁 **a** 同种异体大块骨实物图 **b、c** 术前胸椎正侧位 X 线片,侧位片示 T7、8 椎体大量骨质破坏,局部形成约 60° 后凸角,正位片示椎体有明显脱位 **d、e** 胸椎 MRI 冠状面显示有弥漫的椎旁脓肿,矢状面显示脓肿及死骨突入椎管,压迫脊髓 **f** 病椎横断位的 CT 及 MRI,CT 显示大量死骨形成,MRI 可见椎前及椎旁大量脓肿形成 **g、h** 术后 3 个月的胸椎 X 线片,显示后凸角纠正为 19° **i** 术后 5 年 CT 示大块骨与椎体上下两端均融合 **j** 术后 8 年时患者的全脊柱侧位 X 线片示局部后凸角约 20° ,全脊柱矢状面整体序列良好,无明显后凸畸形

Figure 1 A six-year-old girl **a** A large allograft bone **b, c** Pre-operative X-ray demonstrated destruction of T7 and T8, with a 60° kyphosis measured between T6 and T9, the AP X-ray showed an obvious coronal dislocation **d, e** MRI reveals protrusion of dead bone fragments and granulation tissue into the canal, leading to compression of the dural sac, Pronounced paravertebral abscesses **f** A cross-sectional CT scan showed moth-eaten bone destruction **g** A cross-sectional MRI scan showed huge abscess around the vertebrae **h, i** At the three-month follow up, AP and lateral X-ray was performed, the lateral X-ray indicates that kyphosis was corrected to 19° **j** At the 5-year follow-up, a CT scan showed successful fusion at the grafted site **k** At the 8-year follow-up, a global spine lateral X-ray showed good sagittal plane alignment without kyphosis

间形成骨性连接,达到 1 级融合标准。融合率 100%,2 例发生骨块下端轻度塌陷但无明显植骨块松动及移位,有明显骨痂形成,骨小梁通过,1 例出现局部轻度后凸畸形,但无局部疼痛和神经功能损害。

3 讨论

儿童胸、腰椎脊柱结核是常见的以破坏椎体、椎间盘为主要病理变化的慢性感染性疾病,由于椎体和椎间盘被破坏后形成脓肿和干酪样坏死物导致椎体前中柱塌陷、短缩而形成后凸畸形^[13]或

移位^[14]。加之儿童脊柱尚在生长发育阶段,畸形通常会随着生长发育进行性加重。已有研究报道在已治愈的儿童脊柱结核中,随着生长发育,约 39% 的患儿后凸仍会进一步加重,约 3% 的患儿后凸畸形会超过 60° ,而年龄 <10 岁,治疗前后 Cobb 角 $>30^\circ$ 是后凸畸形进展的危险因素^[7,15],因此对于该类患儿,如果不对后凸畸形及时纠正,随着患儿的生长发育后凸畸形将不可避免地进行性加重,甚至形成僵硬的角状后凸畸形而引起慢性脊髓压迫和损伤,产生迟发性瘫痪^[8]。因此,对于有手术指征的患儿,应当积极予以手术治疗。但



图 2 患儿女性,3 岁 a、b 术前正侧位 X 线片示 L1~L3 椎体被结核病灶严重破坏,大部分骨质消失 c、d 双侧腰大肌巨大脓肿形成、脓肿进入椎管,神经严重受压 e、f 行后路 T11~L5 椎弓根螺钉内固定、L1~4 椎板间植骨融合及前路病灶清除大块异体骨支撑植骨融合,术后 1 周 X 线片可见植骨块较大超出椎体前缘 g 术后 2 年侧位 X 线片示植骨块良好塑形,超出椎体前缘的骨质被完全吸收,已完全融合 h、i 术后 5 年脊柱全长正侧位 X 线片示无明显后凸及侧弯畸形 j 术后 5 年 CT 示植骨处上下两端融合良好

Figure 2 A three-year-old girl a, b Pre-operative X-ray indicating complete disappearance of L2 vertebra c, d MRI demonstrates a huge abscess around the psoas and the spinal cord was compressed by the dead bone fragments and granulation tissue e, f Posterior T11-L5 pedicle screw fixation, L1-4 interlaminar bone graft fusion combined with anterior debridement and reconstruction with allograft bone strut. At 1 week follow-up, X-ray showed complete correction of kyphosis, but the edge of the bone graft exceeds the front edge of the T12 vertebral body g At the 24-month follow-up, the lateral X-ray showed that the bone graft fused well, with the protruding bone at T12 vertebral body being absorbed completely h, i At the 5-year follow-up, the global anteroposterior and lateral X-ray showed no obvious kyphosis and lateral deformity j At the 5-year follow-up, a CT scan showed successful fusion at the grafted site

该采用何种手术方式目前仍有争议。既往已经有国内外同行报道了不同的手术方式:(1)单纯前路病灶清除、植骨融合,虽具有显露充分、病灶清除彻底、前中柱植骨融合等优点,但对于儿童脊柱结核,由于清除病灶的同时,椎体骨骺也被部分或全部破坏,失去继续生长能力,而后方附件结构仍旧具有生长潜能,因此随着生长发育,术后可能再次出现后凸畸形。已有作者通过随访发现单纯前路手术治疗骨破坏较大的儿童脊柱结核远期会发生后凸或侧弯畸形^[16];(2)单纯后路手术的主要优势在于:所有操作均在一个切口内完成,后方附件植骨融合可以预防远期后凸畸形的发生^[17,18],但对于较远的椎旁脓肿很难清除干净^[18,19],而且只有前中柱受累时,单纯后路手术有可能将前方的感染引到后方,增加了后方结构感染的可能性,同时也会破坏健康的后柱稳定性,倘若植骨融合失败则会导致脊柱三柱失稳,造成严重的后果。另外,在骨破坏较大的病灶进行支撑植骨时,由于所需置入物较大,可能对神经牵拉严重,造成短期的神经麻痹甚至永久性的神经损伤。而前后路联合手术兼具二者的优势,但缺点是需在两个切口完成,且手术时间、出血量、住院日相对较多^[20]。选择何种较为合适的支撑植骨材料是个难题。理想的脊柱支撑植骨材料是自体髂骨、腓骨,具有免疫相容性好,骨诱导能力强、融合率高、融合时间短的优点,并且不会因植骨而感染其他传染性疾病^[21-23],但对 10 岁以下儿童来说取自体髂骨植骨是不可行的,因为儿童的髂骨内外层尚无皮质骨而是较厚的软骨,内外层之间的松质骨很薄,故其骨量有限、支撑强度严重不足,而且取骨会影响局部美观,甚至引起取骨区长期疼痛等相关并发症^[22,23]。以成人脊柱前中柱重建经验来看,钛网是比较理想的支撑材料,用于成人颈椎的钛网在尺寸大小方面与儿童的胸腰椎是匹配的且强度足够,但是由于儿童椎体骨质柔软而钛网的齿缘坚硬锐利易切入椎体骨质导致塌陷,并且钛网不能随脊柱生长被改建、塑形。有作者^[24]报道用钛网支撑出现钛网倾斜移位,形成局部畸形融合,所以钛网也不是适合的支撑重建材料。虽然有作者报道尝试用取自患儿母亲的新鲜髂骨来支撑植骨,3 年内的随访发现植骨融合率较高^[25],但这种植骨源有违于法律法规及伦理道德而不可能作为常规术式,且有感染母体疾病可能。还有作者报道了用同种异

体冻干骨作为支撑植骨材料^[21,26],也取得了较好的近期临床效果,但其价格相对高昂,保存相对较难,不易获得。而用于脊柱融合的常规的同种异体骨来源于异体髂骨、具有两面或三面皮质骨,虽然质地较脆但有较好的硬度和支撑强度、能够承受儿童的体重和运动时产生的应力,从临床随访结果来看,大块骨可以被很好地塑形改建,完全融合。大块异体骨块植骨可以获得很高的融合率,本组 19 例患者骨块上下两端全部牢固融合,2 例出现下端轻度塌陷,但均达到 1 级骨性融合,无明显松动及移位,1 例出现轻度后凸畸形,但无神经功能损害及局部疼痛,融合率 100%,国内同行采用同样的术式同样的支撑植骨材料,短期随访也获得了良好的临床效果^[27],本研究病例在更长时间的随访期内临床观察获得了良好的效果。同种异体骨用于儿童胸腰椎前中柱重建具有简便易得、可靠性好、融合率高、可塑形等优点,所以是比较合适的用于儿童脊柱支撑重建的植骨材料。

4 结论

一期后路椎弓根螺钉内固定融合联合前路病灶清除、同种异体骨重建的方法治疗儿童胸腰椎结核是一种安全可行的术式,中、远期随访观察获得了满意的临床结果。

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