

经皮置钉联合微创经椎弓根植骨治疗胸腰椎骨折的临床疗效

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【摘要】 目的:探讨经皮置钉联合微创经椎弓根植骨与非植骨治疗胸腰椎骨折患者的临床疗效。方法:自 2021 年 1 月至 2022 年 6 月,回顾性分析 40 例胸腰椎骨折患者,其中,试验组 26 例,男 21 例,女 5 例;年龄(47.3±12.3)岁;采用经皮椎弓根置钉联合微创经椎弓根自体骨植骨术。对照组 14 例,男 7 例,女 7 例;年龄(50.2±11.2)岁;采用经皮椎弓根螺钉内固定术。比较两组患者手术时间、术中出血量、术前、术后 1 周和术后 3、12 个月伤椎的前缘高度比、伤椎 Cobb 角、疼痛视觉模拟评分(visual analogue scale, VAS)、改良 MacNab 评分及术后内植物松动断裂等并发症情况。结果:两组患者手术时间、术中出血量、VAS 及前缘高度比较,差异无统计学意义($P>0.05$);与术前相比,术后 1 年 VAS 及前缘高度百分比均有显著改善($P<0.05$)。术前两组伤椎 Cobb 角比较,差异无统计学意义($P=0.766$);术后 1 周及术后 3、12 个月两组比较,差异有统计学意义($P<0.05$);与术前相比,术后 12 个月两组伤椎 Cobb 角均有显著降低($P<0.001$)。根据 MacNab 评分,术后 12 个月试验组优 20 例,良 5 例,可 1 例;对照组优 10 例,良 3 例,可 1 例,两组比较,差异无统计学意义($P=0.648$)。对照组术后第 3 天出现 1 例浅表伤口感染,经换药及抗感染治疗后治愈;两组患者术后均无钉棒松动断裂等其他并发症。结论:两种手术方式具有创伤小、疼痛轻、恢复快的优势,均可以恢复伤椎高度、重建脊柱序列,使骨折椎体复位;而伤椎经皮经椎弓根植骨可以增加骨折椎体的稳定性,术后能更好地维持椎体高度,从而降低后凸畸形和钉棒松动断裂等并发症的可能性。

【关键词】 经椎弓根植骨; 经皮置钉; 胸腰椎骨折; 自体骨植骨

中图分类号:R683.2

DOI:10.12200/j.issn.1003-0034.2023.10.006

开放科学(资源服务)标识码(OSID):



Analysis of the clinical effect of percutaneous pedicle screw fixation combined with transpedicular bone grafting in the treatment of thoracolumbar fracture

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ABSTRACT Objective To investigate the clinical efficacy of percutaneous screw fixation combined with minimally invasive transpedicular bone grafting and non-bone grafting in the treatment of thoracolumbar fractures. **Methods** From January 2021 to June 2022, 40 patients with thoracolumbar fracture were divided into the experimental group and the control group. There were 26 patients in the experimental group, including 21 males and 5 females with an average age of (47.3±12.3) years old, who underwent percutaneous pedicle screw fixation combined with transpedicular autogenous bone grafting. In the control group, 14 patients received percutaneous pedicle screw fixation only, including 7 males and 7 females with an average age of (50.2±11.2) years old. The operative time, intraoperative blood loss, anterior height ratio of injured vertebrae, Cobb angle, visual analogue score (VAS), MacNab scores, loosening or broken of the implants, were compared and analyzed. **Results** There was no significant difference in operation time, intraoperative blood loss, VAS and anterior height ratio of injured vertebrae between the two groups. Compared with the preoperative results, VAS and anterior height ratio of injured vertebrae were improved statistically ($P<0.05$). For Cobb angle of injured vertebra, there was no significant difference between the two groups before surgery ($P=0.766$). While at 1 week, 3 months and 12 months after surgery, there were statistically differences between the two groups (P values were 0.042, 0.007 and 0.039, respectively). The Cobb angle of injured vertebrae one year after operation was statistically decreased in both groups compared with that before surgery ($P<0.001$). One year after surgery, the excellent and good

基金项目:上海市卫健委面上项目(编号:202040059);上海市青浦区卫计委青年项目(编号:W2018-11);青浦区科技发展基金项目(编号:QKY2021-08)

Fund program: Supported by Surface project of Shanghai Municipal Health Commission (No. 202040059)

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rate of Macnab scores was 96.15% in the experimental group and 92.86% in the control group, and there was no statistical differences between the two groups ($P=0.648$). There was one patient in the control group suffering superficial wound infection on the third day, which was cured by dressing change and anti-infection treatment. There were no postoperative screw loosening and broken in both groups. **Conclusion** The two surgical methods have the advantages of less trauma, less pain and quicker recovery, which can restore the height of the injured vertebra, reconstruct the spinal sequence and reduce the fracture of the vertebral body. Transpedicular autogenous bone grafting can increase the stability of the fractured vertebra and maintain the height of the vertebra better after surgery, thus reducing the possibility of complications such as kyphosis, screw loosening and broken. **KEYWORDS** Transpedicular bone grafting; Percutaneous pedicle screw fixation; Thoracolumbar fracture; Autogenous bone grafting

脊柱骨折绝大部分为胸腰椎骨折, 手术治疗能够恢复椎体高度, 重建脊柱的序列及稳定性。传统的手术以开放性手术治疗为主^[1], 手术创伤大、出血多、恢复慢。近年来, 随着微创脊柱外科技术的快速发展, 微创经皮置钉技术已经能够治疗绝大部分的胸腰椎骨折^[2-6]。对于部分压缩明显的胸腰椎骨折, 经皮置钉联合体位复位后引起椎体“蛋壳样改变”的处理目前仍存在争议^[7]。有研究认为^[8], 经椎弓根植骨能够增加椎体前柱的支撑作用, 有利于患者早期功能锻炼, 减少术后断钉断棒等并发症的发生。因此, 本研究回顾性分析了 40 例严重压缩的胸腰椎骨折的患者, 比较微创经皮椎弓根钉内固定技术和经皮置钉联合伤椎经皮经椎弓根植骨技术的疗效, 现将结果分析汇报如下。

1 资料与方法

1.1 病例选择

1.1.1 纳入标准 (1)骨折至手术治疗时间在 2 周以内。(2)胸腰椎单节段骨折。(3)骨折椎体椎弓根的单侧或双侧保持完整。(4)脊柱载荷分享评分^[10](load-sharing scoring system, LSC) ≤ 6 分。(5)胸腰椎损伤分型及评分^[11](thoracolumbar injury classification and severity score, TLICS) ≥ 4 分。(6)根据 FRANKEL 等^[12]提出的 Frankel 脊髓损伤分级标准, 评分均为 E 级, 即不伴有神经系统损伤。

1.1.2 排除标准 (1)骨质疏松性或多节段骨折或病理性骨折或陈旧性骨折的患者。(2)术前存在严重凝血功能障碍者。(3)骨折椎体双侧椎弓根均破坏, 无法经椎弓根进行椎体内植骨的患者。(4)骨折块压迫神经, 出现神经损伤症状, 需行椎管减压的患者。(5)合并其他部位严重损伤, 可能影响脊柱骨折治疗或术后康复的损伤。

1.2 一般资料

选取 2021 年 1 月至 2022 年 6 月手术治疗的胸腰椎骨折患者 40 例, 男 28 例, 女 12 例; 年龄 21~68 岁; 车祸伤 31 例, 高坠伤 7 例, 重物砸伤 2 例。根据术前影像学检查(X 线、CT 及 MRI), 骨折按照 AO 分型^[9]分类, A1 型 28 例, A2 型 4 例, A3 型 8 例。试

验组 26 例, 男 21 例, 女 5 例; 年龄(47.3 \pm 12.3)岁; 采用经皮椎弓根置钉联合微创经椎弓根自体骨植骨术治疗。对照组 14 例, 男 7 例, 女 7 例; 年龄(50.2 \pm 11.2)岁; 行单纯的微创经皮椎弓根螺钉内固定术治疗。两组患者性别、年龄、损伤分型比较, 差异无统计学意义($P>0.05$), 具有可比性, 见表 1。本研究经复旦大学附属中山医院青浦分院伦理委员会审批(审批编号:202040059), 所有患者签署知情同意书。

表 1 两组胸腰椎骨折患者一般资料比较
Tab.1 Comparison of the general data of the thoracolumbar fracture patients between two groups

| 组别 | 例数 | 性别/例 | | 年龄($\bar{x}\pm s$)/ 岁 | AO 分型/例 | | |
|-----|----|----------------|---|----------------------------|----------------|------|------|
| | | 男 | 女 | | A1 型 | A2 型 | A3 型 |
| 试验组 | 26 | 21 | 5 | 47.3 \pm 12.3 | 19 | 2 | 5 |
| 对照组 | 14 | 7 | 7 | 50.2 \pm 11.2 | 9 | 2 | 3 |
| 检验值 | | $\chi^2=2.768$ | | $t=-0.735$ | $\chi^2=0.518$ | | |
| P 值 | | 0.096 | | 0.467 | 0.772 | | |

1.3 手术方法

所有手术由同一主任医师主刀完成。脊柱钉棒固定系统由大博医疗科技股份有限公司生产提供。

1.3.1 试验组 气管插管全麻后, 俯卧于可透 X 线的手术台上, 胸腹部放置软垫, 轻度过伸体位下复位骨折椎体, C 形臂 X 线机透视, 定位伤椎及相邻椎体双侧椎弓根并标记。髂骨部常规消毒铺巾, 于髂骨中部沿髂嵴切开 1.5 cm, 依次分离直至髂骨表面, 骨刀去除 3 cm \times 1 cm 骨皮质, 刮匙刮取松质骨备用。冲洗取骨通道, 骨蜡封填骨壁, 逐层缝合切口并包扎。

骨折区常规消毒铺巾, 于骨折上、下位椎体椎弓根体表投影点外侧纵向往切开约 1.5 cm 切口。逐层打开皮下组织及深筋膜, 经肌间隙钝性分离至关节突关节。透视辅助置入椎弓根穿刺针, 随后置入导丝并拔出穿刺针, 沿导丝攻丝并置入 4 枚椎弓根螺钉。根据术前影像, 确定椎弓根相对完整的一侧作为植骨侧, 对侧作为撑开侧。于撑开侧置入连接棒, 并利用器械撑开复位骨折椎。于植骨侧置入较粗、较短的椎

弓根螺钉,随后取出螺钉,以建立植骨通道,并经该通道对椎体终板进行适当撬顶,尽可能复位骨折椎体并建立植骨空间。经该植骨通道置入植骨漏斗,利用植骨推棒将自体骨植入椎体内,逐步压实,并透视确认复位良好,植骨充分,钉棒位置满意,彻底止血,冲洗伤口后逐层缝合并包扎。

1.3.2 对照组 气管插管全麻后,俯卧位置于可透 X 线的手术台上,胸腹部放置软垫,轻度过伸体位下复位骨折椎体。C 形臂 X 线机透视,观察复位良好,定位伤椎上、下位椎体双侧椎弓根,并体表标记。术区常规消毒铺巾,取体表椎弓根标记点外侧 1.5 cm 纵切口,逐层切开至肌肉表面并钝性分离至进针点,透视辅助下置入椎弓根穿刺针,随后置入导丝并拔出穿刺针。沿导丝攻丝并置入 4 枚椎弓根螺钉,依次置入双侧连接棒。再次透视确认钉棒长短及位置满意,彻底止血,冲洗伤口后逐层缝合并包扎。

1.3.3 术后处理 术后第 1 天静脉使用头孢唑啉预防感染,术后 24 h 即开始床上下肢抬腿锻炼,并行影像学检查。术后 1 周后佩戴支具下床活动,2 周拆线,3 个月去除支具。患者定期门诊随访,随访时间 12~26 个月,术后 3、12 个月门诊复查 1 次。

1.4 观察项目与方法

分别于术前、术后 1 周及术后 3、12 个月进行疼痛视觉模拟评分(visual analogue scale, VAS)^[13],评估疼痛缓解情况。术后 12 个月根据 MACNAB^[14]提出的 MacNab 评分方法进行改良,评价生活质量改变的情况。影像学评估:测量伤椎的前缘高度比(伤椎前缘实际高度/伤椎上、下位椎体前缘平均高度)以及伤椎 Cobb 角(侧位 X 线片伤椎上、下终板平行线的夹角),评估伤椎高度恢复及后凸矫正情况。

1.5 统计学处理

采用 SPSS 25.0 软件进行统计分析。两组患者性别、损伤分型比较采用 χ^2 检验,改良 MacNab 评分比较采用秩和检验。两组患者年龄、手术时间、术中出血量、VAS、伤椎前缘高度比、伤椎 Cobb 角等符合正态分布的定量资料采用均数±标准差($\bar{x}\pm s$)表示,两组比较采用成组设计定量资料的 *t* 检验,同组术后 12 个月与术前比较采用配对设计定量资料的 *t* 检验。以 *P*<0.05 为差异有统计学意义。

2 结果

2.1 两组患者一般情况及并发症比较

40 例患者手术均顺利完成,对照组 1 例术后第 3 天出现浅表伤口感染,经换药及抗感染治疗后治愈;术后至末次随访无钉棒松动断裂等并发症。所有患者获得 1 年以上随访。两组手术时间和术中出血量比较,差异无统计学意义(*P*>0.05),见表 2。

表 2 两组胸腰椎骨折患者手术时间及术中出血量比较 ($\bar{x}\pm s$)

Tab.2 Comparison of the operative time and intraoperative blood loss of the thoracolumbar fracture patients between two groups($\bar{x}\pm s$)

| 组别 | 例数 | 手术时间/min | 术中出血量/ml |
|------------|----|------------|------------|
| 实验组 | 26 | 89.69±6.03 | 25.85±4.88 |
| 对照组 | 14 | 60.21±4.30 | 19.14±4.35 |
| <i>t</i> 值 | | 16.179 | 4.298 |
| <i>P</i> 值 | | 0.227 | 0.554 |

2.2 两组临床疗效比较

两组手术前后 VAS 及前缘高度百分比,差异无统计学意义(*P*>0.05);术后 12 个月均优于术前(*P*<0.05),见表 3。根据改良 MacNab 评分,试验组优 20 例,良 5 例,可 1 例;对照组优 10 例,良 3 例,可 1 例,两组相比差异无统计学意义($\chi^2=0.208, P=0.648$),表明两组患者术后生活质量均提高。

表 3 两组胸腰椎骨折患者手术前后 VAS 比较 ($\bar{x}\pm s$)

Tab.3 Comparison of VAS of the thoracolumbar fracture patients between two groups($\bar{x}\pm s$)

| 组别 | 例数 | 单位:分 | | | |
|------------|----|-----------|-----------|-----------|-----------|
| | | 术前 | 术后 1 周 | 术后 3 个月 | 术后 12 个月 |
| 试验组 | 26 | 7.77±0.77 | 2.31±0.84 | 1.92±0.80 | 1.50±1.11 |
| 对照组 | 14 | 7.71±0.83 | 2.14±0.95 | 1.57±0.51 | 1.00±0.88 |
| <i>t</i> 值 | | 0.044 | 0.321 | 2.218 | 2.135 |
| <i>P</i> 值 | | 0.834 | 0.574 | 0.145 | 0.152 |

注:术后 12 个月与术前相比,试验组 *t*=-3.225, *P*<0.05;对照组 *t*=-1.959, *P*<0.05

2.3 两组影像资料比较

术前两组患者伤椎 Cobb 角比较,差异无统计学意义(*P*=0.766);术后 1 周及术后 3、12 个月,两组比较差异有统计学意义(*P*<0.05);术后 12 个月与术前相比,两组伤椎 Cobb 角差异均有统计学意义(*P*<0.001),见表 4。术前及术后 1 周及术后 3、12 个月两组伤椎前缘高度百分比比较,差异均无统计学意义(*P*<0.05);术后 12 个月与术前相比,两组前缘高度百分比比较,差异均有统计学意义(*P*<0.001),见表 5。

本组病例通过影像学分析,提示经皮置钉联合椎体内自体骨植骨技术可以有效地恢复伤椎高度、减轻胸腰椎后凸畸形,并且术后能够维持该矫形效果。典型病例图片见图 1。

3 讨论

胸腰椎骨折是最常见的脊柱骨折,有研究显示

表 4 两组胸腰椎骨折患者手术前后 Cobb 角比较 ($\bar{x}\pm s$)
Tab.4 Comparison of the Cobb angle of injured vertebrae of the thoracolumbar fracture patients between two groups
 ($\bar{x}\pm s$)

| 组别 | 例数 | 术前 | 术后 1 周 | 术后 3 个月 | 术后 12 个月 |
|------------|----|------------|-----------|-----------|-----------|
| 试验组 | 26 | 21.12±2.92 | 3.73±1.87 | 5.12±1.95 | 6.73±3.75 |
| 对照组 | 14 | 21.43±3.57 | 5.29±2.79 | 7.29±2.89 | 9.29±3.32 |
| <i>t</i> 值 | | 0.090 | 4.448 | 8.004 | 4.570 |
| <i>P</i> 值 | | 0.766 | 0.042 | 0.007 | 0.039 |

注: 术后 12 个月与术前相比, 试验组 $t=-8.776, P<0.001$; 对照组 $t=-8.082, P<0.001$

表 5 两组胸腰椎骨折患者手术前后前缘高度百分比比较 ($\bar{x}\pm s$)

Tab.5 Comparison of the anterior height ratio of injured vertebrae of the thoracolumbar fracture patients between two groups ($\bar{x}\pm s$)

| 组别 | 例数 | 术前 | 术后 1 周 | 术后 3 个月 | 术后 12 个月 |
|------------|----|-----------|-----------|-----------|-----------|
| 试验组 | 26 | 0.75±0.06 | 0.93±0.03 | 0.88±0.12 | 0.87±0.11 |
| 对照组 | 14 | 0.72±0.06 | 0.94±0.03 | 0.91±0.03 | 0.90±0.03 |
| <i>t</i> 值 | | 2.064 | 0.559 | 0.629 | 0.750 |
| <i>P</i> 值 | | 0.159 | 0.459 | 0.433 | 0.392 |

注: 术后 12 个月与术前相比, 试验组 $t=8.380, P<0.001$; 对照组 $t=6.232, P<0.001$

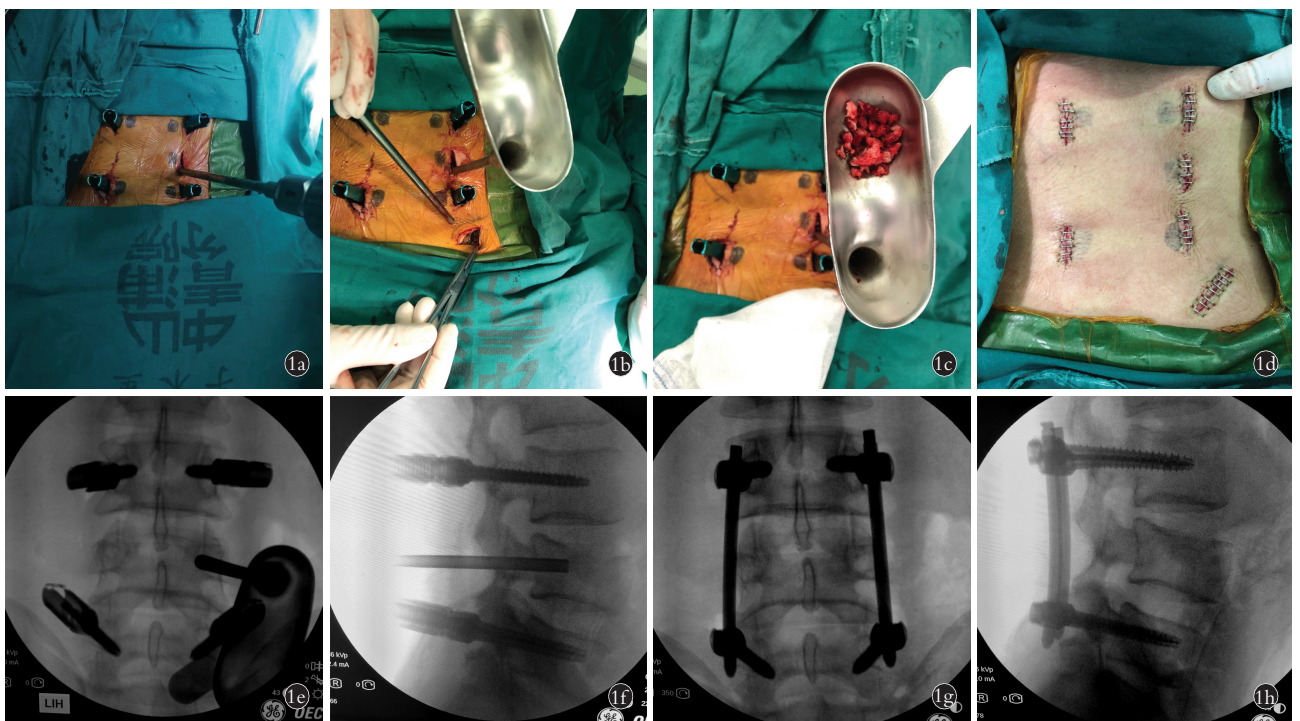


图 1 患者,男,30岁,L4骨折,采用经皮经椎弓根置钉联合自体髂骨植骨 **1a.** 经皮置钉并建立植骨通道:L₃、L₅ 经皮经椎弓根置钉后,于 L₄ 椎体压缩塌陷明显的一侧(该患者右侧)经皮经椎弓根建立植骨通道,插入植骨漏斗 **1b.** 取自体髂骨:右侧髂后上棘外侧 8 cm 左右切开 2.5 cm, 取自体髂骨 **1c.** 自体髂骨植骨:经建立好的植骨通道将自体髂骨碎骨粒植入伤椎骨折塌陷处 **1d.** 皮肤切口情况:采用经皮微创切口,实现既往开放手术才能完成的椎体矫形及伤椎植骨过程 **1e.** 经皮置钉并建立植骨通道的术中正位 X 线片:L₃、L₅ 经皮经椎弓根置钉后,于 L₄ 椎体压缩塌陷明显的一侧(该患者右侧)经皮经椎弓根建立植骨通道,插入植骨漏斗 **1f.** 经皮置钉并建立植骨通道的术中侧位 X 线片:确认植骨漏斗插入椎体内合适深度(术前 CT 中显示的椎体压缩塌陷的部位) **1g.** 术后正位 X 线片确认钉棒位置合适 **1h.** 术后侧位 X 线片确认钉棒位置,可见 L₄ 椎体内上终板下方的植骨影

Fig.1 A 30-year-old male patient percutaneous transpedicular screw fixation combined with autogenous iliac bone grafting underwent with L₄ fracture **1a.** Percutaneous screw insertion and establishment of graft channel:after the insertion of pedicle screws at L₃ and L₅ percutaneously, the bone graft channel was established percutaneously through the pedicle on the right side of L₄ which was obvious compressed and collapsed,and the bone graft funnel was inserted **1b.** Obtaining bone from the iliac crest:scrape out the cancellous bone at the site 8 cm lateral to the the right posterior superior iliac crest with a 2.5 cm incision **1c.** Autogenous iliac bone grafting:the autogenous iliac bone fragments were inserted into the injured vertebral body through the established channel **1d.** Incisions:small incisions were used to this operation which could be completed by open surgery previously **1e.** Antero-posterior X-ray of the operation:after the insertion of pedicle screws at L₃ and L₅,the bone graft channel was established through the pedicle on the right side of L₄ which was obvious compressed and collapsed,and the bone graft funnel was inserted **1f.** Lateral X-ray of the operation:the appropriate depth of the graft funnel was confirmed on the right side of patient **1g.** Anteroposterior X-ray after the operation;confirming the position of the screws and rods **1h.** Lateral X-ray after the operation;confirm the position of the screws and rods ,and the grafted bone can be seen below the upper endplate in the L₄ vertebra body



图 1 患者,男,30 岁,L₄骨折,采用经皮经椎弓根置钉联合自体髂骨植骨 **i**. 术前 X 线正位片:腰椎序列正常,无明显侧弯畸形 **j**. 术前 X 线侧位片:L₄ 椎体上终板塌陷,椎体高度下降,椎体前后缘距离增宽 **k**. 术后 3 个月 X 线正位片:内固定位置良好,椎体高度维持正常 **l**. 术后 3 个月 X 线侧位片:内固定位置良好,椎体高度维持正常,椎体无明显塌陷 **m**. 术前 CT 矢状位片:可见椎体前方劈裂,椎体中部塌陷明显,椎体不稳 **n**. 术后 3 个月 CT 矢状位片:可见内固定位置良好,椎体塌陷区可见完全复位,植骨块支撑上终板,维持椎体高度

Fig.1 A 30-year-old male patient percutaneous transpedicular screw fixation combined with autogenous iliac bone grafting underwent

i. Anteroposterior X-ray before surgery: The lumbar spine sequence was normal without scoliosis **j**. Lateral X-ray before surgery: the upper endplate of L₄ was collapsed, the vertebral height was decreased, and the distance between the anterior and posterior edges of the vertebral body was widened **k**. Anteroposterior X-ray 3 months after surgery: the position of the instrumentation was normal as well as the vertebral height **l**. Lateral X-ray 3 months after surgery: the position of the instrumentation was also normal as well as the vertebral height, and no obvious collapse of the vertebral body was observed **m**. Preoperative sagittal CT radiograph: the split of the anterior vertebral body, collapse at the upper endplate and instability of the vertebral body were observed **n**. Sagittal CT radiograph 3 months after surgery: the position of the instrumentation was normal as well as the vertebral height, with complete reduction of vertebral body and grafted bone supporting the upper endplate

其占脊柱骨折总数 79.2%^[15]。根据骨折的严重程度,分为稳定性骨折和不稳定性骨折,其中不稳定性骨折又分为机械不稳定、神经不稳定及机械和神经不稳定^[16-17]。稳定性骨折往往采用保守治疗,即卧床休息、支具治疗、药物治疗及理疗等手段。不稳定性胸腰椎骨折,尤其是不合并神经系统损伤的胸腰椎压缩或爆裂性骨折,则采用手术治疗,治疗的目的主要是恢复椎体高度,重建脊柱序列,以预防继发的腰背部疼痛及脊柱后凸畸形对脊髓神经系统造成损害。

传统的胸腰椎骨折手术往往采用开放后路椎弓根钉棒内固定术。由于椎弓根钉棒内固定具有三柱稳定作用,能够在骨折治疗的早期提供即刻稳定性,为骨折的骨性愈合提供条件,所以得到广泛应用和推广^[18-19]。然而,后路开放性手术本身切口大、出血多、恢复慢、疼痛明显,对患者的创伤较大。另外,手术暴露过程中需广泛剥离椎旁肌肉,加上拉钩对肌肉长时间的牵拉,容易导致肌肉水肿缺血,术后瘢痕

化及失神经支配,最终导致术后慢性顽固性腰痛的发生^[20-21]。

经皮椎弓根钉棒内固定术由于切口小、出血少、疼痛轻、恢复快,已经成为治疗不伴神经损伤的胸腰椎骨折的主要微创手术方式。HAYOUN 等^[22]对 134 例胸腰椎骨折手术治疗的患者回顾性分析发现,经皮置钉组和开放手术患者出血量分别为 176 ml 和 220 ml,住院时间分别为 3.6 d 和 5.5 d,手术时间分别为 57.1 min 和 51.1 min,两组比较,差异均有统计学意义($P < 0.05$)。本研究显示,经皮置钉组和开放手术组手术出血量,手术时间差异无统计学意义($P > 0.05$)。本研究患者的手术出血量明显降低,可能与主刀医生术中操作精准熟练、止血彻底有关;患者手术时间稍长,与术中进行植骨有关,植骨操作平均增加 0.5 h,但是与非植骨组相比,差异无统计学意义,笔者认为植骨所造成的损伤并不明显增加患者的医源性创伤;两组患者术后 VAS 逐渐降低,

各时间点与术前相比差异有统计学意义,说明经皮手术能够明显减轻患者的疼痛,有利于患者术后康复。对照组术后第 3 天出现 1 例浅表伤口感染,经换药及抗感染治疗后治愈,可能与该患者合并糖尿病有关。

另外,胸腰椎骨折术中行经椎弓根植骨一直存在争议。2001 年,KNOP 等^[23]对 76 例胸腰椎骨折的患者进行至少 3 年的随访,并对其中 56 例去除椎弓根钉棒后进行随访研究发现,这些患者 Cobb 角平均丢失 10.1°,认为经椎弓根植骨无法阻止矫正度的丢失,不建议经椎弓根植骨。然而,笔者发现 KNOP 等^[23]的研究中部分患者的植骨位于椎间隙,并非完全的椎体内植骨,最后导致部分患者植骨不融合及矫正度丢失。2003 年刘团江等^[24]对 32 例胸腰椎爆裂性骨折手术治疗的患者进行研究:骨缺损的发生率为 100%,术后 1 年骨缺损可以愈合缩小但速度较慢,植骨必要。2017 年胡海刚等^[25]对 116 例胸腰椎骨折患者进行回顾性研究发现,62.1%的患者术后出现“空壳现象”;且椎体压缩程度越重,复位后椎体出现空壳的概率越高,因此建议如果椎体压缩程度较重,术中首选自体骨行椎体内支撑。VERLAAN 等^[26]认为,胸腰椎椎体压缩或爆裂性骨折时,受伤椎体高度降低,骨皮质破坏的同时,椎体内松质骨的骨小梁结构被压缩。手术矫形通过对前后纵韧带及椎间盘纤维环的牵拉,使碎裂的骨皮质复位,能够恢复椎体的外形及高度,但被压缩的松质骨骨小梁往往无法恢复原有高度,出现“蛋壳”现象,失去了前中柱的支撑作用,造成骨折椎体高度丢失,最终导致椎弓根钉棒松动断裂。综上所述,笔者认为胸腰椎椎体骨折复位后产生的“空壳”需要植骨填充,提供有效的前中柱支撑,诱导松质骨骨小梁的再生与恢复,最终达到骨折坚强愈合。自体松质骨无免疫原性,同时具有骨诱导和骨传导作用,无疑是最优选择。

本研究试验组患者行经皮椎弓根钉棒固定并行椎体内植骨,对照组单纯行经皮椎弓根钉棒固定,两组患者术后伤椎 Cobb 角术后与术前相比均显著降低,差异有统计学意义,说明两组患者经体位复位及内固定器械复位,可以重建椎体高度,恢复胸腰椎序列;试验组术后各时间点 Cobb 角低于对照组 ($P < 0.05$),说明经椎弓根植骨能够增强椎体前柱的支撑作用,有效降低术后矫正度丢失,植骨有效。两组患者术后 1 年前缘高度百分比与术前相比均显著提高 ($P < 0.05$),但两组间相比差异无统计学意义 ($P > 0.05$),表明两组患者术后椎体复位理想,椎体高度维持较好,经皮置钉联合体位复位及内固定器械复位能够达到手术目的,具有良好的治疗效果。

综上所述,经皮椎弓根钉棒内固定术可以恢复伤椎高度,重建脊柱序列;而伤椎经皮经椎弓根植骨可以增加骨折椎体的稳定性,提高伤椎前柱的支撑能力,术后更好地维持椎体高度,从而降低后凸畸形和钉棒松动断裂等并发症的可能性。

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(收稿日期: 2023-05-06 本文编辑: 连智华)