

# 经皮短节段内固定治疗 Magerl A3 伴低骨密度的胸腰椎骨折

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**【摘要】** 目的: 探讨经皮椎弓根钉短节段内固定加或不加中间螺钉治疗伴有低骨密度的 Magerl A3 胸腰椎骨折的临床疗效。方法: 对 2017 年 1 月至 2020 年 7 月接受经皮椎弓根钉短节段内固定术的 Magerl A3 型胸腰椎骨折的患者进行回顾性分析, 符合诊断和纳入标准的 93 例, 按排除标准排除 9 例, 余 84 例获得完整影像学随访资料。男 38 例, 女 46 例; 年龄 56~73(64.78±7.12) 岁; 骨密度 0.61~0.89(0.73±0.14) g/cm<sup>3</sup>; 随访时间 11~25(17.58±6.12) 个月。其中加中间螺钉(A 组)45 例, 不加中间螺钉(B 组)39 例。记录手术时间和术中出血量, 采用 Oswestry 功能障碍指数(Oswestry Disability Index, ODI)和视觉模拟评分法(visual analogue scale, VAS)进行临床评估。根据术后 X 线片测量 Cobb 角, 椎体楔角(vertebral wedge angle, VWA)和椎体前部高度(anterior vertebral body height, AVBH)进行影像学随访, 并计算上述参数的矫正丢失度。结果: 84 例患者中有 5 例螺钉松动(A 组 2 例, B 组 3 例,  $P>0.05$ ); 两组在手术时间和术中出血量上差异有统计学意义( $P<0.01$ ); 两组临床疗效良好, VAS 和 ODI 明显改善, 两组在所有随访时间(术后 3 d、1 个月、末次随访)的 VAS 和 ODI 差异均无统计学意义( $P>0.05$ ); 术后 3 d 影像学评价(Cobb 角、VWA 和 AVBH)均较术前改善明显( $P<0.05$ ), 但在术后 1 个月和末次随访时, 两组均可观察到明显的复位丢失( $P<0.05$ )。末次随访时, Cobb 角、VWA、AVBH 丢失度(差值)A 组分别是(5.26±4.18)°, (4.63±3.80)°, (9.54±8.71)%; B 组分别是(6.01±4.34)°, (6.55±6.21)°, (11.67±9.95)%; 但两组之间的复位丢失比较差异无统计学意义( $P>0.05$ )。结论: 增加中间伤椎置钉并不能增加其稳定性, 两组经皮短节段内固定均不能抵抗 Magerl A3 胸腰椎骨折骨折合并低骨密度的复位丢失。由于伤椎螺钉增加了手术时间及术中出血量, 因此对低骨密度的老年 Magerl A3 胸腰椎骨折使用中间螺钉意义不大。

**【关键词】** 脊柱骨折; 骨折固定术, 内; 骨密度; 骨质疏松

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**Efficacy of percutaneous short segment fixation in the treatment of Magerl A3 thoracolumbar fractures with low bone mineral density: a retrospective study** LI Wen-chao, LIN Hong-heng, LIU Hong-jiang, and WU Chun-fei. The Third Affiliated Hospital of Guangzhou University of TCM, Guangzhou 518000, Guangdong, China

**ABSTRACT Objective:** To explore the clinical efficacy of percutaneous pedicle screw short segment internal fixation with or without the intermediate screw in the treatment of Magerl A3 thoracolumbar fractures with low bone mineral density. **Methods:** Patients with Magerl A3 thoracolumbar fracture underwent percutaneous pedicle screw short segment internal fixation from January 2017 to July 2020 were retrospectively analyzed, 93 cases met the diagnosis and inclusion criteria, 9 cases were excluded according to the exclusion criteria, and the remaining 84 cases obtained complete imaging follow-up data. There were 38 males and 46 females, the age ranged from 56 to 73 years old with an average of (64.78±7.12) years old, bone mineral density (BMD) ranged from 0.61 to 0.89 g/cm<sup>3</sup> with an average of (0.73±0.14) g/cm<sup>3</sup>, the follow-up time was 11 to 25 months with an average of (17.58±6.12) months. There were 45 cases in group A with intermediate screw and 39 cases in group B without intermediate screw. The operation time and intraoperative blood loss were recorded, Oswestry Disability Index (ODI) and visual analogue scale (VAS) were used for clinical evaluation. The Cobb angle, vertebral wedge angle (VWA) and anterior vertebral body height (AVBH) were measured by X-ray after the operation. The corrected loss of the above parameters was calculated. **Results:** There were 5 cases of screw loosening in 84 patients (2 cases in group A and 3 cases in group B,  $P>0.05$ ). There were significant differences in operation time and intraoperative blood loss between two groups ( $P<0.01$ ). Clinical effects of two groups were good, postoperative VAS and ODI after operation obviously improved, there was no significant difference between two groups during all follow-up periods (3 days, 1 month after operation and the final follow-up) ( $P>0.05$ ). Three days after the operation, the image evaluations (Cobb angle, VWA and AVBH) were significantly improved ( $P<0.05$ ), but significant reduc-

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tion loss was observed in both groups at 1 month after the operation and at the final follow-up ( $P < 0.05$ ). At the final follow-up, the loss of Cobb angle, VWA and AVBH in group A were  $(5.26 \pm 4.18)^\circ$ ,  $(4.63 \pm 3.80)^\circ$  and  $(9.54 \pm 8.71)\%$ , respectively; group B was  $(6.01 \pm 4.34)^\circ$ ,  $(6.55 \pm 6.21)^\circ$  and  $(11.67 \pm 9.95)\%$ , respectively; however, there was no significant difference in reduction loss between the two groups ( $P > 0.05$ ). **Conclusion:** Although the curative effect of the patients is satisfactory, the stability of the patients can not be improved by increasing the middle injured vertebra screw placement, the two groups of percutaneous short segment internal fixation can not resist the reduction loss of Magerl-A3 thoracolumbar fracture with low bone mineral density. Because the injured vertebra screw increases the operation time and intraoperative blood loss, it is not significant to use the intermediate screw for the elderly Magerl A3 thoracolumbar fractures with low bone mineral density

**KEYWORDS** Spinal fractures; Fracture fixation, internal; Bone density; Osteoporosis

胸腰椎区(T<sub>11</sub>-L<sub>3</sub>)的生物力学特性决定了胸腰椎骨折占整个脊柱骨折的60%~70%<sup>[1-2]</sup>。随着人们预期年龄的不断增长,伴随着骨密度(bone mineral density, BMD)降低的胸腰椎骨折越来越多,尤其对60岁左右的患者,不仅耐受不了保守治疗长期卧床带来的生活质量降低,而且还面临着卧床导致骨量进一步丢失、后凸畸形、肺及泌尿系感染等新风险。开放式长节段椎弓根螺钉固定会导致椎旁肌肉损伤和萎缩、失血增多和腰椎术后综合征,并伴有运动节段的过多丢失<sup>[3-5]</sup>。经皮椎体成形术(percutaneous vertebroplasty, PVP),经皮椎体后凸成形术(percutaneous kyphoplasty, PKP)和骨水泥强化椎弓根螺钉固定术被用于治疗严重骨质疏松性脊柱骨折,但骨水泥的渗漏风险、远期骨水泥松动等相关并发症更值得关注<sup>[6-7]</sup>。近年来,以减少椎旁肌损伤和尽快恢复脊柱活动的经皮微创椎弓根螺钉技术越来越受欢迎<sup>[8]</sup>。在伤椎添加中间螺钉可降低平行四边形效应,分散钉棒连接应力,降低断钉的发生率<sup>[9-10]</sup>,基于以上理念,笔者运用经皮微创短节段椎弓根钉加伤椎固定治疗胸腰椎骨折也愈来愈多。既往的临床研究多是在BMD正常的患者中进行的<sup>[11-13]</sup>。很少研究其对低BMD的胸腰椎骨折患者的疗效。本研究选取2017年1月至2020年7月行经皮短节段椎弓根钉内固定加或不加中间伤椎螺钉治疗的Magerl等<sup>[14]</sup>A3型胸腰椎骨折患者84例,分析其临床疗效。

## 1 资料与方法

### 1.1 病例选择

**1.1.1 诊断标准** 有明确外伤史,伤后胸腰背部疼痛,X线片根据Magerl等<sup>[14]</sup>胸腰椎骨折分型标准分型诊断。

**1.1.2 纳入标准** (1)年龄56~73岁。(2)BMD在 $0.6 \sim 0.9 \text{ g/cm}^3$ 。(3)神经功能完好。(4)有明确外伤史,MRI显示新鲜胸腰椎骨折。(5)手术时间在伤后1周内。(6)患者知情并签署知情同意书。

**1.1.3 排除标准** (1)临床资料不完整,包括随访不到2年、医疗依从性差或影像学质量低等。(2)有严重的心脑血管系统等全身性疾病。(3)术后伤口感

染。(4)术后末次随访前再次骨折。(5)伴肿瘤、结核、强直性脊柱炎、类风湿等引起的病理性骨折。

### 1.2 临床资料

在收治196例胸腰椎骨折患者中,术前均行X线和双能X线骨密度仪检查,符合诊断和纳入标准的93例,9例因临床影像资料不全被排除。余84例患者均行经皮短节段椎弓根钉内固定,加中间螺钉(A组)45例,不加中间螺钉(B组)有39例。男38例,女46例;年龄56~73( $64.78 \pm 7.12$ )岁;骨密度 $0.61 \sim 0.89$  ( $0.73 \pm 0.14$ )  $\text{g/cm}^3$ ;随访时间11~25 ( $17.58 \pm 6.12$ )个月。两组患者的基线人口学特征,BMD,脊柱载荷分布评分<sup>[15]</sup>(load-sharing scoring, LSC),骨折部位和受伤原因等差异无统计学意义( $P < 0.05$ )。见表1。

### 1.3 治疗方法

**1.3.1 手术方法** 全身麻醉后,患者被放置在一个透光手术台上,适度折床及按压以促进骨折的复位。在靶节段两侧做3 cm的旁正中切口,并延伸到皮下组织。螺钉的入口点选择在前后图像椎弓根边缘的三点(左侧)或九点(右侧)处。在透视引导下沿着椎弓根的中心轴钻孔,以确保穿刺针在前后图像中不会穿过椎弓根的内侧边缘,直到在外侧图像中穿过椎弓根的后缘。在检查内侧和尾部角度后,将导丝插入孔中,取出穿刺针。在透视引导下,经皮双螺纹椎弓根螺钉沿导丝置入椎体。将双侧单轴椎弓根螺钉置入骨折处上下椎弓根。是否使用多轴螺钉(35 mm)固定伤椎,取决于术者的经验。各螺钉放置到位后,根据骨折水平的正常生理矢状线,对具有适当长度的钛棒进行折弯,通过撑开复位螺钉来复位椎体、矫正脊柱后凸。两组典型病例见图1-2。

**1.3.2 术后处理** 术后3 d内鼓励患者带支具站立,获得术后站立X线片。所有患者于术后1、3个月、1~2年返回本科进行临床和影像学检查。确定骨折已骨性愈合后,置入内固定物均被拆除,以避免螺钉断裂,恢复节段运动。

### 1.4 观察项目与方法

**1.4.1 一般情况及相关并发症观察** 记录两组患者术中失血量、手术时间及相关并发症。

**1.4.2 临床疗效评价** 采用视觉模拟评分法(visual analogue scale, VAS)和 Oswestry 功能障碍指数(Oswestry Disability Index, ODI) 问卷收集患者手术前后的临床资料。术前根据 CT 采用脊柱载荷分布评分(load-sharing scoring, LSC)评估骨折程度。

**1.4.3 影像学评价** 所有患者术后 3 d、1 个月和末次随访前均行直立位 X 线片检查,观察指标包括 Cobb 角,椎体楔角(vertebral wedge angle, VWA)和椎体前部高度(anterior vertebral body height, AVBH)。Cobb 角是指上椎骨上终板和下椎骨下终板之间的夹角;VWA 是骨折椎体上下终板之间的夹角;AVBH 的测量按[(伤椎前缘高度)/(上位椎体前缘高度+下位椎体前缘高度)/2]×100%计算<sup>[16]</sup>,以术后 1 个月、末次随访与术后 3 d 的差值来计算 Cobb 角、VWA、

AVBH 的矫正丢失度<sup>[16]</sup>。所有数据由 1 名未参与治疗的独立观察者审查。

**1.5 统计学处理**

采用 SPSS 22.0 对数据进行统计学分析。定量资料以均数±标准差( $\bar{x}\pm s$ )表示,并采用独立样本 *t* 检验对两组患者的年龄、骨密度、LSC、手术时间、术中失血量、VAS、ODI、Cobb 角、VWA 和 AVBH 等数据进行比较。采用  $\chi^2$  检验对受伤原因和并发症及有序数据(骨折程度)进行分析。采用 LSD 检验法分析比较各组不同时间的 Cobb 角、VWA 和 AVBH。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相关并发症比较**

两组手术时间、术中出血量比较差异有统计学

表 1 两组胸腰椎骨折患者一般资料比较

Tab.1 Comparison of general data of patients with thoracolumbar fractures between two groups

| 组别         | 例数 | 年龄<br>( $\bar{x}\pm s$ , 岁) | 性别(例)          |    | 骨折椎体分布(例)       |                 |                |                |                | 随访时间<br>( $\bar{x}\pm s$ , 月) | 骨密度<br>( $\bar{x}\pm s/\text{cm}^3$ ) | 载荷分布评分<br>( $\bar{x}\pm s$ , 分) | 受伤原因(例)        |    |      |
|------------|----|-----------------------------|----------------|----|-----------------|-----------------|----------------|----------------|----------------|-------------------------------|---------------------------------------|---------------------------------|----------------|----|------|
|            |    |                             | 男              | 女  | T <sub>11</sub> | T <sub>12</sub> | L <sub>1</sub> | L <sub>2</sub> | L <sub>3</sub> |                               |                                       |                                 | 跌倒             | 车祸 | 轻微暴力 |
| A 组        | 45 | 64.34±4.74                  | 20             | 25 | 6               | 13              | 16             | 8              | 2              | 16.93±7.16                    | 0.73±0.12                             | 5.18±0.77                       | 30             | 9  | 6    |
| B 组        | 39 | 65.55±10.08                 | 18             | 21 | 5               | 11              | 14             | 7              | 2              | 18.02±7.04                    | 0.72±0.13                             | 5.45±0.80                       | 26             | 8  | 5    |
| 检验值        |    | <i>t</i> =0.723             | $\chi^2=0.004$ |    | $\chi^2=0.109$  |                 |                |                |                | <i>t</i> =1.183               | <i>t</i> =0.105                       | <i>t</i> =1.235                 | $\chi^2=0.081$ |    |      |
| <i>P</i> 值 |    | 0.60                        | 0.87           |    | 0.71            |                 |                |                |                | 0.09                          | 0.70                                  | 0.20                            | 0.96           |    |      |

注:A 组为手法复位经皮椎弓根短节段内固定加中间螺钉固定治疗组;B 组为手法复位经皮椎弓根短节段内固定不加中间螺钉固定治疗组。下同

Note: Group A was treated with manual reduction, percutaneous pedicle screw short segment internal fixation and intermediate screw fixation; group B was treated with manual reduction and percutaneous pedicle screw short segment internal fixation without intermediate screw fixation. The same below



图 1 男性患者,65 岁,因“跌伤致伤腰背疼痛 2 d”2017 年 11 月 27 日入院,诊断为 L<sub>2</sub> 椎体新鲜压缩性骨折,术前 BMD 为 0.784 g/cm<sup>3</sup>,VAS 为 9 分,ODI 为 91.11 分。采用手法复位、经皮短节段椎弓根螺钉固定加中间螺钉固定治疗 1a. 术前 X 线片示 L<sub>2</sub> 椎体压缩性骨折 1b. 术后 3 d X 线示复位良好 1c. 术后 1 个月 X 线片示复位明显丢失 1d. 术后 14 个月 X 线示骨折已愈合,复位丢失未增加

Fig.1 A 65-year-old male patient was admitted to hospital on November 27, 2017 due to "two days of low back pain caused by falling injury". He was diagnosed with fresh compression fracture of L<sub>2</sub> vertebral body. Preoperative BMD was 0.784 g/cm<sup>3</sup>, VAS was 9 scores and ODI was 91.11 scores. Manipulative reduction and percutaneous short segment pedicle screw fixation plus intermediate screw fixation were performed 1a. Preoperative X-ray showed compression fracture of L<sub>2</sub> vertebral body 1b. Three days after operation, X-ray showed good reduction 1c. One month after operation, X-ray showed the reduction was significantly lost 1d. At 14 months after operation, X-ray showed that the fracture had healed and the loss of reduction did not increase



图 2 女性患者,61 岁,因“扭伤致伤腰背疼痛 1 周”2018 年 1 月 27 日入院,诊断为 L<sub>1</sub> 椎体新鲜压缩性骨折,术前腰椎 BMD 为 0.684 g/cm<sup>3</sup>,VAS 为 8 分,ODI 为 89.23 分,采用椎体手法复位经皮椎弓根短节段内固定不加中间螺钉固定术治疗 2a. 术前 X 线片示 L<sub>1</sub> 椎体压缩性骨折 2b. 术后 2 d X 线片示复位良好 2c. 术后 1.5 个月 X 线片示复位明显丢失 2d. 术后 20 个月 X 线片示骨折已愈合,复位丢失未增加

**Fig.2** A 61-year-old female patient was admitted to hospital on January 27, 2018 because of "low back pain caused by sprain for one week". She was diagnosed with fresh compression fracture of L<sub>1</sub> vertebral body. Preoperative lumbar BMD was 0.684 g/cm<sup>3</sup>,VAS was 8 scores and ODI was 89.23 scores. Manual reduction and percutaneous short segment pedicle screw fixation without intermediate screw fixation were performed 2a. Preoperative X-ray showed fresh compression fracture of L<sub>1</sub> vertebral body 2b. Two days after operation, X-ray showed the reduction was good 2c. At 1.5 months after operation, X-ray showed the reduction was obviously lost 2d. At 20 months after operation, X-ray showed that the fracture had healed and the loss of reduction did not increase

意义( $P < 0.05$ );螺钉松动 5 例(A 组 2 例,B 组 3 例),两组比较差异无统计学意义( $P = 0.086$ )。见表 2。所有螺钉松动患者接受保守治疗,并在末次随访中显示出良好的结果,两组均无骨不连、神经损伤和感染等并发症。

然而,两组间各时间点比较差异均无统计学意义( $P > 0.05$ ),见表 3-4。

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

**Tab.3 Comparison of pre-and post-operation VAS of patients with thoracolumbar fractures between two groups**  
( $\bar{x} \pm s$ , score)

| 组别         | 例数 | 术前        | 术后 3 d                 | 术后 1 个月                 | 末次随访                     |
|------------|----|-----------|------------------------|-------------------------|--------------------------|
| A 组        | 45 | 8.32±1.09 | 3.16±0.68*             | 1.53±0.69**             | 0.41±0.21***             |
| B 组        | 39 | 8.45±0.67 | 2.91±0.53 <sup>▲</sup> | 1.32±0.78 <sup>▲▲</sup> | 0.38±0.19 <sup>▲▲▲</sup> |
| <i>t</i> 值 |    | 0.654     | 1.091                  | 0.981                   | 1.003                    |
| <i>P</i> 值 |    | 0.55      | 0.14                   | 0.29                    | 0.20                     |

注:与术前比较,\* $t = 2.278, P < 0.05$ ;\* $t = 2.236, P < 0.01$ ;\*\*\* $t = 2.922, P < 0.01$ ;<sup>▲</sup> $t = 2.366, P < 0.05$ ;<sup>▲▲</sup> $t = 2.236, P < 0.01$ ;<sup>▲▲▲</sup> $t = 2.967, P < 0.01$   
Note: Compared with preoperative data,\* $t = 2.278, P < 0.05$ ;\* $t = 2.236, P < 0.01$ ;\*\*\* $t = 2.922, P < 0.01$ ;<sup>▲</sup> $t = 2.366, P < 0.05$ ;<sup>▲▲</sup> $t = 2.236, P < 0.01$ ;<sup>▲▲▲</sup> $t = 2.967, P < 0.01$

表 2 两组胸腰椎骨折患者一般情况及相关并发症比较  
**Tab.2 Comparison of general conditions and complications of patients with thoracolumbar fractures between two groups**

| 组别         | 例数 | 手术时间<br>( $\bar{x} \pm s$ , min) | 术中出血量<br>( $\bar{x} \pm s$ , ml) | 并发症(例)           |
|------------|----|----------------------------------|----------------------------------|------------------|
| A 组        | 45 | 121.70±13.27                     | 32.57±4.85                       | 2                |
| B 组        | 39 | 81.89±8.24                       | 22.11±5.05                       | 3                |
| 检验值        |    | $t = 7.289$                      | $t = 9.670$                      | $\chi^2 = 0.004$ |
| <i>P</i> 值 |    | 0.000                            | 0.000                            | 0.086            |

2.2 临床疗效评价

两组患者术后 VAS 和 ODI 均明显下降 ( $P < 0.05$ )。术后 3 d,A 组和 B 组 VAS 已分别降至(3.16±0.68)分和 (2.91±0.53)分,ODI 分别降至 (36.63±6.57)分和 (35.73±5.11)分;术后 1 个月 A 组和 B 组 VAS 分别为 (1.53±0.69)分和 (1.32±0.78)分,ODI 分别为 (10.53±6.02)分和 (9.18±5.47)分;末次随访 A 组和 B 组 VAS 分别为 (0.41±0.21)分和 (0.38±0.19)分,ODI 分别为 (4.37±1.34)分和(4.55±0.93)分。

2.3 影像学评价

两组术后 3 d 骨折椎体的 Cobb 角,VWA 和 AVBH 均较术前有显著改善( $P < 0.05$ )。术后 3 d、1 个月、末次随访两组间 Cobb 角、VWA 和 AVBH 比较差异无统计学意义( $P > 0.05$ )。但在术后 1 个月、末次随访均观察到 Cobb 角、VWA 和 AVBH 的矫正丢失 ( $P < 0.05$ )。见表 5。术后 1 个月和末次随访 Cobb 角、VWA 和 AVBH 的矫正丢失两组间差异无统计学意

义( $P>0.05$ )。见表 6。

### 3 讨论

对于无神经损伤的胸腰椎骨折的治疗一直存在争议<sup>[17-18]</sup>。目前,保守治疗 Magerl A0、A1 和 A2 型胸

腰椎骨折以及手术治疗 Magerl B 和 C 型胸腰椎骨折已被广泛接受,然而对无神经功能缺失的 Magerl A3 型骨折,还没有普遍共识<sup>[18-19]</sup>。LSC 被广泛用于临床指导手术。许多作者建议,LSC 在 4~6 分的胸腰椎

表 4 两组胸腰椎骨折患者手术前后 ODI 比较( $\bar{x}\pm s$ ,分)

Tab.4 Comparison of pre-and post-operation ODI of patients with thoracolumbar fractures between two groups( $\bar{x}\pm s$ , score)

| 项目     | A 组(45 例)  |             |             |             | B 组(39 例)  |             |            |             |
|--------|------------|-------------|-------------|-------------|------------|-------------|------------|-------------|
|        | 术前         | 术后 3 d      | 术后 1 个月     | 末次随访        | 术前         | 术后 3 d      | 术后 1 个月    | 末次随访        |
| 疼痛程度   | 4.12±0.59  | 2.16±0.68   | 1.21±0.28   | 0.86±0.35   | 4.10±0.63  | 2.21±0.53   | 1.23±0.17  | 0.88±0.41   |
| 生活自理能力 | 4.22±0.23  | 2.32±0.31   | 0.67±0.15   | 0.11±0.02   | 4.32±0.35  | 2.35±0.57   | 0.71±0.26  | 0.15±0.06   |
| 提物     | 4.51±0.14  | 2.43±1.46   | 1.23±0.34   | 0.67±0.12   | 4.57±0.16  | 2.38±2.02   | 1.33±0.41  | 0.74±0.17   |
| 行走     | 4.31±0.12  | 1.89±2.09   | 0.63±0.45   | 0.53±0.21   | 4.29±0.22  | 1.93±2.75   | 0.65±0.39  | 0.55±0.24   |
| 坐      | 4.21±0.35  | 1.99±1.05   | 0.55±0.14   | 0.66±0.08   | 4.24±0.57  | 2.11±1.09   | 0.59±0.24  | 0.69±0.11   |
| 站立     | 4.11±0.21  | 1.79±1.27   | 0.45±0.21   | 0.20±0.05   | 4.15±0.30  | 1.82±2.36   | 0.48±0.33  | 0.21±0.04   |
| 社会活动   | 4.62±0.14  | 2.53±2.02   | 1.45±0.39   | 0.60±0.09   | 4.70±0.21  | 2.59±1.98   | 1.46±0.36  | 0.61±0.08   |
| 旅行     | 4.77±0.08  | 2.03±1.81   | 2.68±0.36   | 1.24±0.29   | 4.78±0.19  | 2.06±1.74   | 2.76±0.72  | 1.26±0.32   |
| 睡眠     | 3.89±0.58  | 1.89±0.27   | 0.89±0.33   | 0.29±0.03   | 3.90±0.67  | 1.91±0.57   | 0.91±0.37  | 0.28±0.05   |
| 总分     | 86.68±8.86 | 36.63±6.57* | 10.53±6.02* | 4.37±1.34** | 89.00±6.46 | 35.73±5.11* | 9.18±5.47* | 4.55±0.93** |

注:两组比较,术前, $t=1.110, P=0.28$ ;术后 3 d, $t=1.922, P=0.08$ ;术后 1 个月, $t=1.593, P=0.13$ ;末次随访, $t=0.566, P=0.70$ 。组内术后 3 d、术后 1 个月、末次随访分别与术前比较,采用 LSD 检验法, \* $P<0.05$ , \*\* $P<0.01$

Note: Comparison between two groups, preoperation,  $t=1.110, P=0.28$ ; three days after operation,  $t=1.922, P=0.08$ ; one month after operation,  $t=1.593, P=0.13$ ; at the final follow-up,  $t=0.566, P=0.70$ . LSD-test was used to compare the results of three days, one month after operation and the final follow-up in the group with those before operation, \* $P<0.05$ , \*\* $P<0.01$

表 5 手术前后两组胸腰椎骨折患者影像学参数的比较( $\bar{x}\pm s$ )

Tab.5 Comparison of pre-and post-operation imaging changes of patients with thoracolumbar fractures between two groups ( $\bar{x}\pm s$ )

| 组别    | 例数 | Cobb 角(°) |        |         |         | VWA (°) |        |         |        | AVBH (%) |        |         |         |
|-------|----|-----------|--------|---------|---------|---------|--------|---------|--------|----------|--------|---------|---------|
|       |    | 术前        | 术后 3 d | 术后 1 个月 | 末次随访    | 术前      | 术后 3 d | 术后 1 个月 | 末次随访   | 术前       | 术后 3 d | 术后 1 个月 | 末次随访    |
| A 组   | 45 | 15.08±    | 5.08±  | 9.47±   | 10.34±  | 17.58±  | 7.61±  | 10.74±  | 11.24± | 64.58±   | 89.82± | 81.23±  | 80.29±  |
|       |    | 12.41     | 11.63* | 11.43** | 11.71** | 4.30    | 3.12*  | 4.41**  | 4.51** | 13.46    | 4.80*  | 9.97**  | 9.69**  |
| B 组   | 39 | 15.36±    | 3.45±  | 8.18±   | 10.45±  | 18.73±  | 5.45±  | 11.82±  | 12.00± | 61.00±   | 91.72± | 77.66±  | 76.05±  |
|       |    | 7.55      | 9.94*  | 12.53** | 12.31** | 6.53    | 2.97*  | 5.97**  | 6.40** | 10.11    | 6.09*  | 13.00*  | 12.26** |
| $t$ 值 |    | 0.047     | 1.159  | 0.528   | 0.013   | 0.624   | 1.537  | 0.785   | 0.505  | 1.173    | 1.308  | 1.114   | 1.492   |
| $P$ 值 |    | 0.92      | 0.23   | 0.69    | 0.97    | 0.57    | 0.11   | 0.41    | 0.63   | 0.28     | 0.19   | 0.23    | 0.15    |

注:与术前比较,采用 LSD 检验法, \* $P<0.05$ , \*\* $P<0.01$

Note: LSD-test was used to compare preoperative and postoperative 3 days, 1 month and the final follow-up, \* $P<0.05$ , \*\* $P<0.01$

表 6 两组胸腰椎骨折患者术后不同时期的 Cobb 角, VWA, AVBH 矫正丢失比较( $\bar{x}\pm s$ )

Tab.6 Comparison of corrective loss of Cobb angle, VWA, AVBH at different times after operation between two groups( $\bar{x}\pm s$ )

| 组别    | 例数 | 术后 1 个月   |           |            | 末次随访      |           |            |
|-------|----|-----------|-----------|------------|-----------|-----------|------------|
|       |    | Cobb 角(°) | VWA (°)   | AVBH (%)   | Cobb 角(°) | VWA (°)   | AVBH (%)   |
| A 组   | 45 | 4.39±4.25 | 4.11±3.92 | 9.59±8.76  | 5.26±4.18 | 4.63±3.80 | 9.54±8.71  |
| B 组   | 39 | 5.73±5.14 | 5.36±5.73 | 11.07±9.82 | 6.01±4.34 | 6.55±6.21 | 11.67±9.95 |
| $t$ 值 |    | 1.439     | 1.012     | 1.077      | 1.142     | 1.156     | 1.402      |
| $P$ 值 |    | 0.16      | 0.07      | 0.08       | 0.09      | 0.26      | 0.17       |

骨折应进行短节段固定,这是大多数 Magerl A3 型骨折的等级,而 LSC $\geq$ 7 分的胸腰椎骨折应进行长节段固定<sup>[19-20]</sup>。随着脊柱微创技术的发展,经皮椎弓根螺钉在胸腰椎骨折的治疗中得到了广泛应用,与开放手术相比,它具有减少出血和肌肉损伤,术后疼痛小和恢复时间短等诸多优点<sup>[8]</sup>。对于无神经损伤的 Magerl A3 型骨折,手术目的不是减压,而是矫正畸形和稳定骨折平面,经皮短节段椎弓根钉复位固定成为其首选方法。既往研究在骨折处增加中间伤椎螺钉可以降低平行四边形效应,分散钉棒连接应力,降低断钉的发生率,增加术中时间和出血量<sup>[10-11,13]</sup>,但几乎是在年轻患者或 BMD 正常的患者中进行的。对于中老年骨质疏松性胸腰椎骨折,PVP、PKP 和骨水泥强化椎弓根螺钉固定术是常用疗法,临床疗效令人满意,但骨水泥渗漏且不具备骨传导性,远期骨水泥松动及相邻椎应力骨折等诸多并发症对 60 岁左右伴骨量减少的老年胸腰椎骨折患者不是最佳的治疗方法<sup>[21]</sup>,保守长期卧床导致骨量进一步丢失、骨不连、后凸和背痛<sup>[22]</sup>。骨水泥螺钉固定固然是一种好选择,但水泥渗漏和螺钉不能被拆除、丧失一定运动节段等会导致生活质量的大大下降,对预期仍有 20 年寿命的老年人来说,往往不被接受。

众所周知,椎弓根的抗拔出力受腰椎 BMD 的影响最大,我国正常青壮年的腰椎 BMD<sup>[23]</sup>男性(1.065 $\pm$ 0.138) g/cm<sup>3</sup>,女性(0.996 $\pm$ 0.151) g/cm<sup>3</sup>。研究表明当骨密度低于 0.9 g/cm<sup>3</sup> 时<sup>[24-25]</sup>,椎弓根螺钉在体内就达不到足够的稳定性。当 BMD 在 0.6~0.7 g/cm<sup>3</sup> 用骨水泥强化可提供足够的稳定性,而当 BMD $<$ 0.6 g/cm<sup>3</sup> 时,即使应用骨水泥强化,螺钉松动风险依然较高。无论男女,腰椎 BMD 在 50~69 岁均加速下降<sup>[23]</sup>,正常男性在(0.983 $\pm$ 0.183)~(0.963 $\pm$ 0.199) g/cm<sup>3</sup>,女性(0.813 $\pm$ 0.173)~(0.798 $\pm$ 0.165) g/cm<sup>3</sup>。BMD 降低-1 个标准差<sup>[23]</sup>男性相当于 0.927 g/cm<sup>3</sup>,女性相当于 0.845 g/cm<sup>3</sup>。由于老年人生活方式不太活跃,对拔出力的要求相对减少。加之螺钉固定技术的改进,如双螺纹椎弓根螺钉可能比单螺纹螺钉具有更强的拔出力,以及可膨胀螺钉<sup>[26]</sup>、增大内倾角置钉<sup>[27]</sup>等。近年来笔者对 60 岁左右伴骨量减少但骨质疏松不严重的老年胸腰椎骨折多采用经皮椎弓根螺钉来治疗,比开放手术能更好地保护背部肌肉<sup>[12]</sup>,术后也可达到即刻的稳定和部分的后凸矫正。为分析其疗效,笔者将 BMD 在 0.6~0.9 g/cm<sup>3</sup>,无神经功能障碍的 Magerl A3 型胸腰椎骨折患者,严格按照纳入和排除标准筛选病例,分为加中间螺钉 A 组和不加中间螺钉 B 组。其中是否使用较短的中间多轴螺钉支撑伤椎,主要凭个人经验,并无标准。结果发现:A 组手术时

间较 B 组延长,术中出血量增多,说明应用中间螺钉明显增加了术中创伤。两组的临床疗效均令人满意,两组的影像学结果(Cobb 角、VWA、AVBH 测量)在术后立即得到改善( $P<0.05$ ),VAS 和 ODI 明显改善,在术后各个随访时间与术前比较,差异有统计学意义( $P<0.05$ ),说明两组患者均能获得良好的稳定性。但组间比较差异无统计学意义( $P>0.05$ ),因此加用伤椎螺钉并不能明显增加临床疗效。然而,在随访期间,两组均出现了明显的复位丢失( $P<0.05$ ),且大多数发生术后的第 1~2 个月,在手术 1 个月和末次随访时,两组骨折的矫正丢失度差异无统计学意义( $P>0.05$ ),组间比较差异也无统计学意义( $P>0.05$ )。说明经皮螺钉固定这种稳定性是有限的,不能维持老年人日常生活中所需的畸形矫正。在随访期间复位的丢失,说明即使应用中间螺钉也并不能产生与正常骨密度患者所取得的相同结果。末次随访丢失度较术后 1~2 个月并无显著增加。分析可能既与椎体的 BMD 低、抗拔除力差有关,还与带腰围下地后老年人的竖脊肌无力、重心前移等老年人胸腰椎的生物力学特点密切相关,Sebaaly 等<sup>[28]</sup>研究认为 Roussouly 4 种类型的胸腰椎形态即使无骨折,随着年龄的增大,最终都会出现后凸,甚则矢状面失平衡。因此,对老年低骨密度的 Magerl A3 型胸腰椎骨折行经皮椎弓根螺钉治疗的目的是矫正畸形,而是稳定骨折平面,防止畸形加重,治疗疼痛和改善生活质量。如需矫正和维持畸形纠正,可选择长节段固定或骨水泥增强螺钉固定或辅以椎体植骨和椎体融合。Okuyama 等<sup>[29]</sup>认为在低骨密度的胸腰椎骨折,后路椎弓根螺钉内固定可增加骨不连的风险,但本组病例并无发生骨折不愈合。两组均在透视下置入椎弓根螺钉,无神经功能损伤。螺钉松动 5 例,两组比较差异无统计学意义,虽然松动的原因尚不清楚,但也表明使用中间螺钉并不能增加内固定的稳定性,只起到了支撑作用,还可导致手术时间延长和额外的术中失血,因为两组之间的都出现了一定程度的矫正丢失,临床疗效等各项指标测量均无显著差异,这进一步说明加用中间螺钉治疗低骨密度的 Magerl A3 型胸腰椎骨折是不必要的。

本研究局限在一个小的人群中进行,两组之间的统计差异、矫正丢失与骨密度之间的相关性还需进一步探讨。这是一项回顾性研究,在病例选择方面存在一定偏差,但患者的性别、年龄、BMD、LSC 和骨折程度组间差异无统计学意义。此外,由于随访期短,因此很难预测研究的长期结果。

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