

· 临床论著 ·

单侧与双侧椎弓钉固定腰椎后路椎体间融合比较[△]

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摘要: [目的] 比较单侧和双侧椎弓根钉棒内固定后路腰椎间融合术 (posterior lumbar interbody fusion, PLIF) 治疗腰椎退变性疾病疗效。[方法] 回顾性分析 2018 年 8 月—2021 年 6 月本院采用 PLIF 治疗腰椎退变性疾病 90 例患者的临床资料。根据术前医患沟通结果, 48 例采用单侧固定, 42 例采用双侧固定。比较两组围手术期、随访及影像指标。[结果] 单侧组在手术时间 [(108.3±10.7) min vs (155.8±17.1) min, $P<0.05$]、术中失血量 [(121.2±18.4) ml vs (186.7±18.3) ml, $P<0.05$]、住院时间 [(10.2±3.4) d vs (11.8±3.7) d, $P<0.05$] 均显著少于双侧组, 但两组切口长度、术中透视次数、下地行走时间、切口愈合等级的差异均无统计学意义 ($P>0.05$)。随访时间平均 (29.1±6.2) 个月。两组恢复完全负重活动时间的差异无统计学意义 ($P>0.05$)。随着时间推移, 两组患者腰痛及腿痛 VAS 评分、ODI 及 JOA 评分均显著改善 ($P<0.05$)。术后 6 个月单侧组的 ODI [(25.5±6.2)% vs (28.5±7.4)%], $P<0.05$ 和 JOA 评分 [(20.5±2.2) vs (19.6±1.8), $P<0.05$] 显著优于双侧组, 但两组之间 VAS 评分差异无统计学意义 ($P>0.05$), 末次随访时, 两组上述评分的差异均无统计学意义 ($P>0.05$)。影像方面, 与术前相比, 术后 6 个月及末次随访时, 两组椎间隙高度、前凸 Cobb 角均显著改善 ($P<0.05$), 相应时间点, 两组间上述影像指标及融合率的差异均无统计学意义 ($P>0.05$)。[结论] 单侧椎弓根钉棒内固定联合椎间融合术可重建患者脊柱稳定性, 恢复患者脊柱功能, 可以减少手术损伤。

关键词: 腰椎退变性疾病, 后路腰椎间融合术, 椎弓根钉固定, 单侧, 双侧

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Posterior lumbar interbody fusion with unilateral versus bilateral pedicle screw fixations for lumbar degenerative diseases

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Abstract: [Objective] To compare the clinical efficacy of posterior lumbar interbody fusion (PLIF) with unilateral versus bilateral pedicle screws fixations for lumbar degenerative diseases. [Methods] A retrospective study was done on 90 patients who received PLIF for lumbar degenerative diseases in our hospital from August 2018 to June 2021. According to preoperative doctor-patient communication, 48 patients underwent unilateral fixation, while other 42 patients underwent bilateral fixations. The perioperative period, follow-up and imaging documents were compared between the two groups. [Results] The unilateral group proved significantly superior to the bilateral group in terms of operation time [(108.3±10.7) min vs (155.8±17.1) min, $P<0.05$], intraoperative blood loss [(121.2±18.4) ml vs (186.7±18.3) ml, $P<0.05$] and hospital stay [(10.2±3.4) days vs (11.8±3.7) days, $P<0.05$], despite statistically insignificant differences in incision length, intraoperative fluoroscopy times, walking time and incision healing grade between the two groups ($P>0.05$). The average follow-up time was (29.1±6.2) months, and there was no a significant difference between the two groups in the time to return to full weight-bearing activities ($P>0.05$). The VAS scores of low back pain and leg pain, as well as ODI and JOA scores significantly improved in both groups over time ($P<0.05$). At 6 months after surgery, the unilateral group was significantly better than the bilateral group regarding to ODI [(25.5±6.2)% vs (28.5±7.4)%], $P<0.05$ and JOA scores [(20.5±2.2) vs (19.6±1.8), $P<0.05$] regardless of insignificant difference in VAS score between the two groups ($P>0.05$), whereas all abovesaid clinical scores became not statistically significant between the two groups at the last follow-up ($P>0.05$). Radiologically, the vertebral space height and lordotic Cobb angle significantly improved in both groups at 6 months after surgery and at the last follow-up compared with those preoperatively ($P<0.05$). However, there were no statistically significant differences in the above image indexes and fusion rate between the two groups at any time points correspondingly ($P>0.05$). [Conclusion] The unilateral pedicle screw fixation PLIF does restore spinal stability, restore spinal function and reduce surgical injury in this study.

Key words: lumbar degenerative disease, posterior lumbar interbody fusion, pedicle screw fixation, unilateral, bilateral

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腰椎退变性疾病是中老年人腰腿疼痛的主要病因^[1, 2]。非手术治疗,如理疗、牵引等,往往效果不佳。对于出现疼痛、麻木症状的退变患者,后路腰椎间融合 (posterior lumbar interbody fusion, PLIF) 可以对责任节段减压,并重建脊柱稳定^[3]。双侧椎弓根螺钉内固定是一种常用的固定方法,为不稳定椎体运动单元和退变的椎间隙融合提供理想的力学环境^[4]。但生物力学研究显示,该方案会因内固定系统的刚度过大导致更多的临床不良反应,特别是邻近节段退变,此外双侧固定还存在手术时间长、失血量大和医疗成本高等弊端^[5]。

为了解决这些不足,单侧椎弓根螺钉内固定 TLIF 已逐步在临床上获得应用。然而,单侧固定的安全性和生物力学特性仍然存在争议。Hiyama 等^[6]临床研究显示,单侧固定组的融合器沉降比双侧固定严重。但 Vigneshwara 等^[7]对 233 例腰椎退变患者 2 年随访显示,单侧固定组与双侧固定组的疼痛和功能障碍评分及椎间融合率 (97.3% vs 98.3%) 均无显著差异,但单侧固定手术时间、术中失血量显著优于双侧固定。本研究对单侧固定与双侧固定治疗中老年人腰椎退变的长期疗效进行回顾性研究,报道如下。

1 资料与方法

1.1 纳入与排除标准

纳入标准:(1)单节段腰椎退变性疾病,包括椎间盘突出 (disc herniation, DH)、椎管狭窄 (canal stenosis, CS) 和退行性滑脱 (degenerative spondylolisthesis, DS);(2)存在典型的腰痛和(或)下肢放射性疼痛或麻木;(3)经严格保守治疗 6 个月,症状无缓解甚至加重;(4)均行单节段 PLIF 术。

排除标准:(1)存在其他脊柱疾病史和手术史;(2)临床资料不完善。

1.2 一般资料

回顾性分析本院 2018 年 8 月—2021 年 6 月对腰椎退变性疾病行 PLIF 患者临床资料,共 90 例患者符合上述标准,纳入本研究。按照术前医患沟通结果,48 例采用单侧椎弓根螺钉固定 PLIF,42 例采用双侧椎弓根固定 PLIF。两组患者术前一般资料见表 1,两组术前年龄、性别、BMI、病程、病变节段、术前诊断等一般资料的差异均无统计学意义 ($P>0.05$)。本研究经医院医学伦理委员会批准,所有患者及家属均签署知情同意书。

表 1. 两组患者术前一般资料比较
Table 1. Comparison of preoperative general data between the two groups

| 指标 | 单侧组 (n=48) | 双侧组 (n=42) | P 值 |
|--|----------------|----------------|-------|
| 年龄 (岁, $\bar{x} \pm s$) | 54.1 \pm 3.2 | 55.0 \pm 2.9 | 0.168 |
| 性别 (例,男/女) | 26/22 | 22/20 | 0.865 |
| BMI (kg/m ² , $\bar{x} \pm s$) | 25.3 \pm 2.1 | 25.8 \pm 2.4 | 0.295 |
| 病程 (月, $\bar{x} \pm s$) | 9.1 \pm 1.6 | 9.3 \pm 2.1 | 0.610 |
| 节段 (例, L _{3/4} /L _{4/5} /L ₅ S ₁) | 12/20/16 | 10/18/14 | 0.989 |
| 诊断 (例, DH/CS/DS) | 22/14/12 | 20/13/9 | 0.826 |

1.3 手术方法

单侧组:患者取俯卧位,行全身麻醉。于患病椎体处取后正中切口,逐层分离组织,钝性分离最长肌与多裂肌之间的间隙,暴露椎板、横突及关节突。通过 C 形臂 X 线机明确椎弓根入针点并置入导针,确定其深度及位置合适后,置入螺钉撤除导针。咬除部分椎板及关节突,牵开硬脊膜和神经根,暴露椎间盘,对椎间盘突出和椎管狭窄减压,摘除髓核突出部及椎间盘软骨终板,注意保护神经根。将融合器置入椎间隙,植入部分术中咬除的碎骨进行固定。通过 C 形臂 X 线机确定融合器及螺钉位置,最后安装横棒螺母。放置引流,逐层缝合切口,加压包扎。

双侧组:同样采用后正中切口,剥离两侧竖脊肌,暴露椎板及关节突。进行双侧椎弓根螺钉置入,椎管减压、髓核摘除、融合器置入等操作同单侧组。

术后处理:术后常规使用激素、脱水剂及抗生素,记录术后总引流量,术后 24~48 h 拔除引流管。术后即可进行踝关节功能及直腿抬高训练,根据恢复情况 1~3 周可下床活动。术后 3 个月内禁止过度弯腰。

1.4 评价指标

记录围手术期资料,包括手术时间、切口总长度、术中失血量、术中透视次数、下地行走时间、切口愈合、住院时间等。采用疼痛视觉模拟评分法 (visual analogue scale, VAS)、Oswestry 功能障碍 (Oswestry Disability Index, ODI) 和日本骨科学会 (Japanese Orthopaedic Association, JOA) 评分评价临床效果^[8]。行影像学检查:依据 X 线片测量其椎间隙高度、腰椎前凸角 (L₁~S₁ Cobb 角), Bridwell Interbody Fusion Grading 椎间融合评级,对于可疑融合的患者,需行 CT 进一步判定^[9, 10]。

1.5 统计学方法

采用 SPSS 26.0 统计学软件进行数据处理。计量

数据以 $\bar{x} \pm s$ 表示, 资料呈正态分布时, 两组间比较采用独立样本 t 检验, 组内时间点比较采用单因素方差分析; 资料呈非正态分布时, 采用秩和检验。计数资料采用 χ^2 检验或 Fisher 精确检验。等级资料两组比较采用 Mann-whitney-U 检验。 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 围手术期资料

两组患者均顺利完成手术, 均无神经根损伤或血管损伤病例。两组患者围手术期资料见表 2。单侧组的手术时间、术中失血量、住院时间显著少于双侧组 ($P < 0.05$), 但是, 两组切口长度、术中透视次数、下地行走时间、切口愈合等级的差异均无统计学意义 ($P > 0.05$)。早期并发症方面, 单侧组共出现 2 例 (4.2%), 其中 1 例为切口感染, 给予抗感染治疗及加强切口管理后, 切口愈合; 另 1 例为腰部皮肤感觉麻木, 经甲钴胺等营养神经治疗后好转。双侧组共出现 2 例 (4.8%), 其中 1 例为脑脊液漏, 引流 4 d 后拔除引流管, 加压包扎 7 d 后无脑脊液漏; 另 1 例为切口感染, 处理方式同单侧组。

表 2. 两组患者围手术期资料比较

| 指标 | 单侧组 (n=48) | 双侧组 (n=42) | P 值 |
|------------------------------|---------------|---------------|--------|
| 手术时间 (min, $\bar{x} \pm s$) | 108.3±10.7 | 155.8±17.1 | <0.001 |
| 切口长度 (cm, $\bar{x} \pm s$) | 8.2±1.8 | 8.5±0.7 | 0.313 |
| 术中失血量 (ml, $\bar{x} \pm s$) | 121.2±18.4 | 186.7±18.3 | <0.001 |
| 术中透视次数 (次, $\bar{x} \pm s$) | 3.7±0.5 | 3.8±0.4 | 0.302 |
| 下地行走时间 (d, $\bar{x} \pm s$) | 5.4±1.1 | 5.6±1.2 | 0.412 |
| 切口愈合 (例, 甲/乙/丙) | 42/5/1 | 35/6/1 | 0.848 |
| 住院时间 (d, $\bar{x} \pm s$) | 10.2±3.4 | 11.8±3.7 | 0.035 |

2.2 随访结果

两组患者均获随访 12~48 个月, 平均 (29.1±6.2) 个月, 两组随访结果见表 3。两组恢复完全负重活动时间的差异无统计学意义 ($P < 0.05$)。随着时间推移, 两组患者腰痛 VAS 评分、腿痛 VAS 评分、ODI 及 JOA 评分均显著改善 ($P < 0.05$)。术前两组间上述指标差异均无统计学意义 ($P > 0.05$), 术后 6 个月, 单侧组 ODI 和 JOA 评分显著优于双侧组 ($P < 0.05$), 但两组之间 VAS 评分差异无统计学意义 ($P > 0.05$)。末次随访时, 两组 VAS、ODI 及 JOA 评分差异无统计学意义 ($P > 0.05$)。

随访期间两组患者均无症状再加重, 均无翻修手术。

2.3 影像评估

两组影像评估结果见表 4, 与术前相比, 术后 6 个月两组患者椎间隙高度、前凸 Cobb 角均显著改善 ($P < 0.05$)。末次随访时, 椎间隙高度和前凸 Cobb 角均较术后 6 个月略小, 但差异无统计学意义 ($P > 0.05$)。相应时间点时间点, 两组间椎间隙高度、前凸 Cobb 角度的差异均无统计学意义 ($P > 0.05$)。椎间植骨融合情况: 与术后 6 个月相比, 末次随访时, 两组融合率均显著增加 ($P < 0.05$), 相应时间点两组间融合率的差异无统计学意义 ($P > 0.05$)。随访期间两组患者无内固定断裂、松动及融合器移位。

3 讨论

双侧椎弓根钉棒内固定联合椎间融合术自发明以来, 广泛运用于腰椎退变性疾病, 其可以重建腰椎稳定性, 极大地缓解腰部症状, 同时有研究表明置入融合器可以促进椎体的生物融合, 降低椎弓根钉棒的应力^[10-14]。但随着钉棒内固定使用率的提高及随访时间的延长, 发现双侧椎弓根钉棒内固定联合椎间融合术仍存在一些不足, 如坚强固定可引起植骨区应力遮挡, 导致固定椎体骨量丢失所致的骨质疏松; 同时邻近椎体应力及活动度增加, 也可加速邻近椎体的退变, 使很多患者被迫进行二次手术^[15]。相关研究表明单侧椎弓根钉棒内固定联合椎间融合术为非坚强固定^[16-18]。

本组病例末次随访时, 两组患者的随访指标较术前均显著改善 ($P < 0.05$); 两组患者 VAS 评分、ODI 评分、JOA 评分组间比较差异无统计学意义 ($P > 0.05$); 两组患者的影像学指标如椎间隙高度、前凸 Cobb 角较术前均显著改善 ($P < 0.05$), 但两组之间并无显著差异。证实了单侧椎弓根钉棒内固定联合椎间融合术可取得与双侧手术相同的临床疗效。Li 等^[19]有限元分析显示, 融合前, 单侧固定模型的 L_{4/5} 节段的运动范围是双侧固定模型的 2.1、1.3 和 1.7 倍, 而融合后分别为 1.3、1.1 和 1.4 倍。同时, 单侧固定模型应力峰值是双侧固定模型的 1.0~1.7 倍, 融合后则为 1.0~1.4 倍。单侧椎弓根钉棒相对更容易出现应力集中, 因此应尽量保护对侧椎板和小关节的完整性, 避免出现内固定断裂。

单侧组的手术时间、术中失血量、住院时间均显著优于双侧组患者 ($P < 0.05$), 表明单侧椎弓根钉棒

内固定联合椎间融合术相比双侧手术具有更好的安全性。分析其原因：单侧椎弓根钉棒内固定手术仅剥离一侧椎旁肌，对患者损伤较小，减少了出血量，同时

减少手术时间；使用一侧螺钉固定，可减少手术费用。本结果与 Liu^[20]、Zhong^[21]、Zhao^[22] 等对多年临床文献的荟萃分析结果相一致。

表 3. 两组患者随访结果 ($\bar{x} \pm s$) 与比较
Table 3. Comparison of follow-up results between the two groups ($\bar{x} \pm s$)

| 指标 | 时间点 | 单侧组 (n=48) | 双侧组 (n=42) | P 值 |
|---------------|---------|------------|------------|-------|
| 完全负重活动时间 (d) | | 25.3±2.7 | 24.8±2.4 | 0.359 |
| 腰痛 VAS 评分 (分) | 术前 | 6.4±1.1 | 6.3±1.2 | 0.681 |
| | 术后 6 个月 | 2.4±0.5 | 2.3±0.6 | 0.391 |
| | 末次随访 | 1.2±0.3 | 1.1±0.3 | 0.118 |
| | P 值 | <0.001 | <0.001 | |
| 腿痛 VAS 评分 (分) | 术前 | 6.1±1.5 | 6.4±1.3 | 0.317 |
| | 术后 6 个月 | 2.5±1.6 | 2.3±1.5 | 0.544 |
| | 末次随访 | 1.3±0.4 | 1.2±0.3 | 0.188 |
| | P 值 | <0.001 | <0.001 | |
| ODI 评分 (%) | 术前 | 59.7±4.5 | 59.4±3.8 | 0.735 |
| | 术后 6 个月 | 25.5±6.2 | 28.5±7.4 | 0.039 |
| | 末次随访 | 18.3±2.8 | 18.1±3.3 | 0.756 |
| | P 值 | <0.001 | <0.001 | |
| JOA 评分 (分) | 术前 | 15.8±4.5 | 17.1±3.9 | 0.149 |
| | 术后 6 个月 | 21.5±2.2 | 19.6±1.8 | 0.036 |
| | 末次随访 | 24.3±2.1 | 23.8±1.8 | 0.232 |
| | P 值 | <0.001 | <0.001 | |

表 4. 两组患者影像资料比较
Table 4. Comparison of imaging data between the two groups

| 指标 | 时间点 | 单侧组 (n=48) | 双侧组 (n=42) | P 值 |
|--------------------------------|---------|------------|------------|-------|
| 椎间隙高度 (mm, $\bar{x} \pm s$) | 术前 | 8.6±0.6 | 8.5±0.8 | 0.356 |
| | 术后 6 个月 | 11.2±1.1 | 11.4±0.9 | 0.215 |
| | 末次随访 | 10.5±0.7 | 10.7±0.8 | 0.215 |
| | P 值 | <0.001 | <0.001 | |
| 腰椎前凸角 (°, $\bar{x} \pm s$) | 术前 | 25.2±4.9 | 25.6±4.5 | 0.689 |
| | 术后 6 个月 | 30.5±2.2 | 30.2±2.2 | 0.602 |
| | 末次随访 | 29.7±2.6 | 29.9±3.1 | 0.740 |
| | P 值 | <0.001 | <0.001 | |
| Bridwell 椎间融合 (例, I/II/III/IV) | 术后 6 个月 | 28/9/6/5 | 8/7/4/24 | 0.258 |
| | 末次随访 | 44/3/1/0 | 39/2/1/0 | 0.167 |
| | P 值 | <0.001 | <0.001 | |

本次研究仍存在部分有待完善的问题：(1) 未对腰椎退变性疾病不同分型的患者分别进行研究，特别是对一些不同程度骨质疏松症的患者是否仍允许使用单侧椎弓根固定有待进一步的基础研究^[23]；(2) 仅对 TLIF 入路下的单侧椎弓根固定，而伴随着脊柱微创技术的发展，在其他入路下两种固定方式是否存在

差异，仍有待研究^[24, 25]。

综上所述，单侧椎弓根钉棒内固定联合椎间融合术可重建患者脊柱稳定性，恢复脊柱功能，同时可以减少手术损伤，降低手术费用。因此，单侧椎弓根钉棒内固定对于单节段腰椎退变性疾病患者可取得满意的临床疗效。

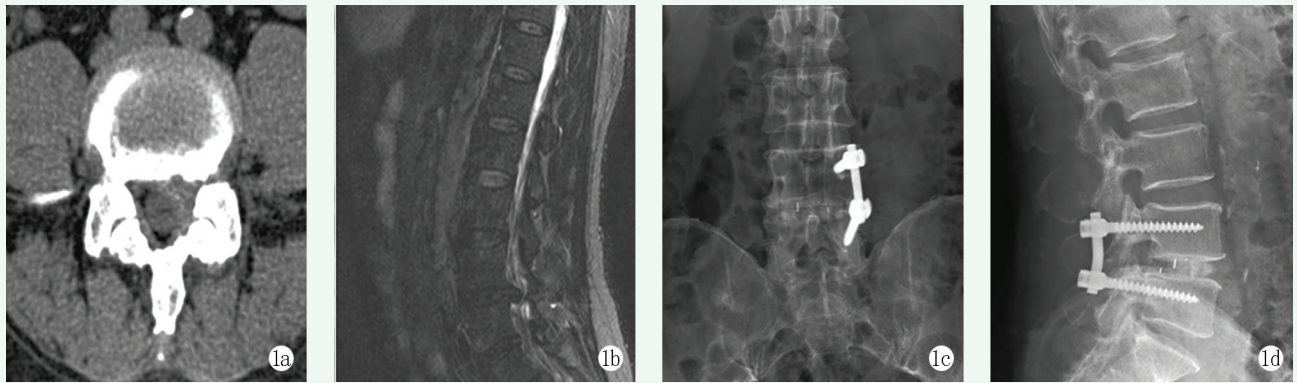


图 1. 患者男性, 55 岁, 反复腰痛 4 年, 伴左下肢放射痛 3 个月余, 诊断为 $L_{4/5}$ 椎间盘突出症, 行单侧椎弓根钉棒内固定 PLIF。1a, 1b: 术前腰椎 MRI 显示 $L_{4/5}$ 椎间盘突出症; 1c, 1d: 术后腰椎正侧位 X 线片显示融合器及椎弓根钉棒位置良好。

Figure 1. A 55-year-old male suffered recurrent low back pain for 4 years, associated with radiating pain in the left lower limb for more than 3 months, was diagnosed as $L_{4/5}$ disc herniation and underwent PLIF with unilateral pedicle screw fixation. 1a, 1b: Preoperative lumbar MRI showed $L_{4/5}$ disc herniation; 1c, 1d: Postoperative lumbar anteroposterior and lateral radiographs showed that the fusion cage and pedicle screw-rods were in good position.

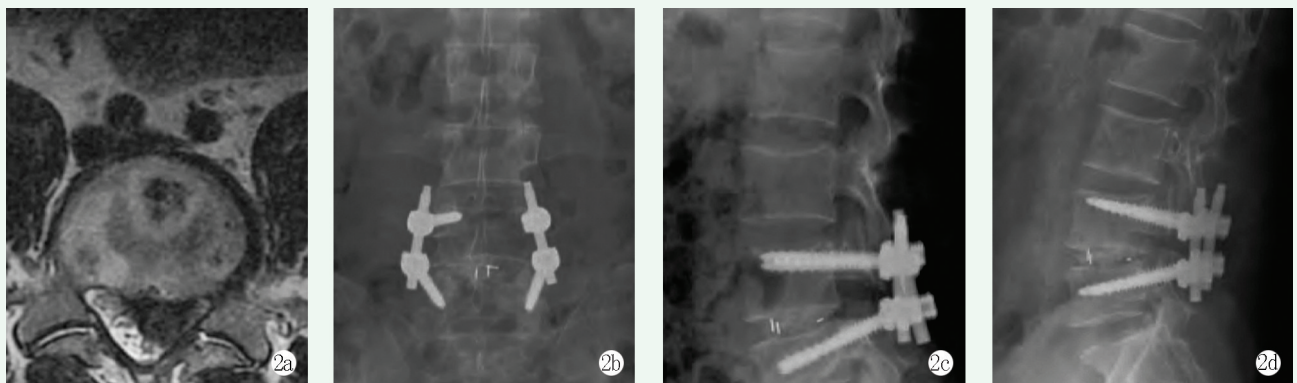


图 2. 患者女性, 52 岁, 反复腰痛 3 年, 伴左下肢放射痛 3 个月余, 诊断为 $L_{4/5}$ 椎间盘突出症, 行双侧椎弓根钉棒内固定 PLIF。2a: 术前腰椎 MRI 显示 $L_{4/5}$ 椎间盘突出症; 2b~2d: 术后腰椎正侧位 X 线片显示融合器及椎弓根钉棒位置可接受。

Figure 2. A 52-year-old female suffered recurrent low back pain for 3 years, and radiating pain of the left lower limb for more than 3 months, was diagnosed with $L_{4/5}$ disc herniation and underwent PLIF with bilateral pedicle screw-rod fixation. 2a: Preoperative lumbar MRI showed $L_{4/5}$ disc herniation; 2b~2d: Postoperative anteroposterior and lateral radiographs of the lumbar spine showed acceptable position of the fusion cage and pedicle screw-rod system.

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