·临床研究·

单侧双通道内镜下经对侧入路治疗腰椎间孔狭窄症的临床疗效

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【摘要】　目的：评估单侧双通道内镜技术经对侧入路治疗腰椎椎间孔狭窄症的可行性及影像学结果。**方法**：回顾性分析 2021 年 1 月至 2022 年 7 月收治的 33 例接受单侧双通道内镜技术治疗腰椎间孔狭窄症患者的临床资料，男 17 例，女 16 例；年龄 34~72（56.00±7.89）岁；记录手术时间、围手术期并发症；采用疼痛视觉模拟评分法（visual analogue scale，VAS）评估患者腰痛和下肢疼痛程度，Oswestry 功能障碍指数（Oswestry disability index，ODI）评估腰椎功能状况；末次随访时采用改良 Macnab 评分标准评价临床疗效。**结果**：所有患者顺利完成手术，手术时间 47~65（56.10±5.19）min；术后随访 12~18（14.9±2.3）个月。术前腰腿痛 VAS［（7.273±1.442）分，（7.697±1.447）分］，ODI（69.182±9.740）%；术后腰腿痛 VAS［（3.394±0.966 分，（2.818±0.727）分］，ODI（17.30±4.78）%；末次随访腰腿痛 VAS［（2.788±0.650）分，（2.394±0.704）分］，ODI（14.33±3.50）%。术后腰腿痛 VAS 及 ODI 与术前比较，差异均有统计学意义（$P<0.05$）。1 例术后出现脑脊液漏，经治疗后状况良好。末次随访时，根据改良 Macnab 评定标准，优 24 例，良 5 例，可 2 例，差 2 例。**结论**：单侧双通道内镜下经对侧入路治疗腰椎间孔狭窄症，操作安全、高效，并发症少，术后恢复快，临床疗效满意，在随访期间，患者未出现医源性腰椎不稳定。

【关键词】　腰椎间孔狭窄症；　单侧双通道内镜技术；　经皮内镜腰椎间盘切除术
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DOI：10.12200/j.issn.1003-0034.20221040　　开放科学（资源服务）标识码（OSID）：

Contralateral endoscopic approach for lumbar foraminal stenosis using unilateral biportal endoscopic surgery

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ABSTRACT　**Objective** To assess the feasibility and imaging outcomes of unilateral biportal endoscopic technique in the treatment of lumbar foraminal stenosis through contralateral approach. **Methods** The clinical data of 33 patients with lumbar foraminal stenosis treated with unilateral biportal endoscopic technique from January 2021 to July 2022 were retrospectively analyzed. There were 17 males and 16 females; age ranging from 34 to 72 years old with an average of (56.00±7.89) years old; operation time and perioperative complications were recorded; visual analogue scale (VAS) of pain was recorded, to evaluate the degree of low back pain and lower extremity pain, and Oswestry disability index (ODI) to evaluate the lumbar spine function. At the latest follow-up, the modified Macnab score was used to evaluate the clinical efficacy. **Results** All patients successfully completed the operation. The operation time ranged from 47 to 65 minutes, with an average of (56.10±5.19) minutes. The postoperative follow-up ranged from 12 to 18 months, with an average of (14.9±2.3) months. The VAS of low back and lower extermity pain before operation were (7.273±1.442) and (7.697±1.447) scores, ODI was (69.182±9.740)%. Postoperative lumbocrural pain VAS were (3.394±0.966) and (2.818±0.727) scores, ODI was (17.30±4.78) %. At the latest follow-up, VAS of back and lower extermity pain was (2.788±0.650) and (2.394±0.704) scores, ODI was (14.33±350)%. There were significant differences in VAS of low back and lower extremity pain and ODI before and after operation ($P<0.05$). At the latest follow-up, according to the modified Macnab criteria, 24 patients got excellent result, 5 as good, 2 as fair, and 2 as poor. **Conclusion** Unilateral biportal endoscopic treatment of lumbar foraminal stenosis through the contralateral approach is a safe and efficient method, with few complications, quick postoperative recovery, and satisfactory clinical outcomes. During the follow-up period, no iatrogenic lumbar instability was observed.

KEYWORDS　Lumbar foraminal stenosis;　Unilateral biportal endoscopic;　Percutaneous endoscopic discectomy

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腰椎间孔狭窄症(lumbar foraminal stenosis, LFS)是一种相对常见的疾病，占退行性腰椎疾病的 8%~11%[1]。治疗症状性腰椎间孔狭窄症的手术目标是通过适当的神经减压缓解症状，同时保留脊柱原有的解剖结构和生物力学。目前，腰椎间孔狭窄症主要有两种外科治疗选择：减压融合和简单减压。椎间孔狭窄的传统手术方法目前分为全椎间孔切除加腰椎融合术和保留小关节的显微椎间孔减压术[2-3]。经 Wiltse 入路的椎间孔减压术被认为是椎间孔或椎间孔外区域狭窄的金标准，报道成功率约为 80%[4-5]。然而，由于视野有限，Wiltse 方法可能导致手术减压不完整。最近，几位作者报道了使用单侧双门内窥镜技术进行脊柱手术的研究[6]。本研究回顾性分析 2021 年 1 月至 2022 年 7 月收治的 33 例接受单侧双通道内镜 (cunlateral biportal endoscopiy, UBE)技术治疗腰椎间孔狭窄症患者的临床资料，旨在评估使用 UBE 技术进行椎间孔减压的临床和放射学结果。

1　资料与方法

1.1　病例选择

纳入标准：(1)单侧下肢症状，伴或不伴有腰痛。(2)CT 及 MRI 证实椎间孔区狭窄，症状与影像学相符合。(3)经系统保守治疗 6 周以上无效。排除标准：(1)伴有节段不稳定或椎体滑移。(2)合并重度脊柱畸形。(3)身体状况差，不能耐受手术。

1.2　一般资料

本组共 33 例，男 17 例，女 16 例；年龄 34~72(56.00±7.89)岁。手术节段：$L_{3,4}$ 1 例，$L_{4,5}$ 19 例，L_5S_1 13 例，所有患者术前经 CT 及 MRI 证实椎间孔狭窄、出口神经根周围脂肪消失，并按照 LEE 等[7]提出的 LFS 分级标准，1 级 2 例，2 级 17 例，3 级 14 例。患者主要症状表现为下肢的麻木、疼痛、间歇性跛行，伴或不伴有腰痛，其中 16 例存在明显静息痛，6 例表现为间歇性跛行。所有手术由同一术者完成。本研究方案经医院伦理委员会批准(伦理批准文号：2022LH001)。

1.3　治疗方法

1.3.1　手术方法　患者采取气管插管全身麻醉后，俯卧于手术床，双侧上肢外展上举放置于支臂板上，双侧腋下放置腋垫，圆柱形体位垫垫高躯干部两侧，使腹部悬空，双侧髋关节、膝关节呈屈曲位。折叠手术床使责任椎间隙与地面垂直。C 形臂 X 线机正侧位透视确定目标椎间隙、棘突中线及椎弓根内缘线等标志并在皮肤标记。切口及内镜下减压常规消毒铺巾后铺放防水膜。正位透视确定对侧椎弓根内缘线以及棘突与椎板水平线，两线交点上下 1.5 cm 分别为操作切口以及观察切口。分级扩张软组织形成观察通道及操作通道。观察通道置入内镜，操作通道置入等离子射频刀头，打开灌注系统，冲洗至视野清晰，形成初始工作空间。用等离子射频以棘突与椎板交界处为中心分离软组织，显露头端椎板下缘、关节突关节。用枪钳咬除或动力磨钻磨除部分上椎板下缘，显露近端黄韧带止点，倾斜关节镜并使用等离子射频刀头显露上位棘突根部，使用动力磨钻磨除棘突根部骨性组织以显露双侧黄韧带“V”领。将关节镜镜头跨过“V”字领实现“过顶”到达对侧，再次使用动力磨钻磨除对侧上位椎板内侧骨质。建立椎板与黄韧带间隙，直至显露对侧椎弓根内缘和下位椎体上关节突，磨除上关节突的内侧部分打开对侧骨性侧隐窝。咬除椎间孔区域黄韧带，逐渐显露对侧神经根，利用神经剥离子分离其与周围组织的粘连，使神经根松解，确认无活动性出血后，放置引流管，完成缝合操作。

1.3.2　术后处理　术后严格卧床 3 d，3 d 后可佩戴腰围适当下地行走锻炼。术后 3 个月内以卧床休息为主，期间行直腿抬高、小燕飞等腰背肌锻炼；可佩戴腰围下地活动。注意避免弯腰及体力劳动。

1.4　观察指标

1.4.1　临床疗效评价　比较患者术前、术后即刻以及末次随访，患者腰腿痛采用视觉模拟评分(visual analogue scale, VAS)[8]、Oswestry 功能障碍指数(Oswestry disability Index, ODI)[9]，以及随访期内并发症和再手术情况。末次随访采用改良 Macnab 评价标准[10]：优，原有症状无残留，恢复至患病前水平；良，有轻微疼痛、麻木等症状，尚可忍受，下肢功能轻度受限，对日常工作、生活无明显影响；可，疼痛、麻木症状较术前部分缓解，下肢活动受限，对工作、生活有一定的影响；差，术后患者疼痛、麻木症状较术前无明显改善，甚至加重，明显影响工作、生活。

1.4.2　影像学测量指标　术前、术后以及末次随访时均获得患者腰椎正侧位和动力位平片。随访期间观察到节段性不稳定的发展或医源性腰椎滑脱的进展。术后 3 d 行 MRI 检查是否存在任何术后并发症，如神经减压不足、髓核组织残留、小关节破坏和术后血肿。测量小关节面的长度，并计算了同侧/对侧术前和术后轴位 T2 MRI 图像中小关节面的长度(图 1)。小关节平面的术前比率和术后比率的差异百分比称为小关节的切除率。

1.5　统计学处理

采用 SPSS 25.0 软件进行统计分析，术前、术后及末次随访的腰痛、腿痛 VAS、ODI 评分为定量资料以均数±标准差($\bar{x}\pm s$)表示，两组间比较采用独立样本 t 检验，多组间比较采用方差分析，以 $P<0.05$ 为差

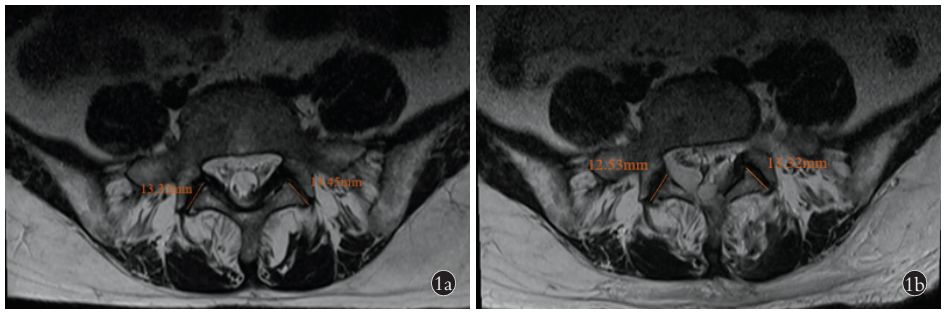

图 1　测量小关节平面长度及比值　**1a.** 计算术前轴向 T2 磁共振成像图像中对侧/同侧小关节平面长度的比值，术前比值为 0.99(13.32:13.45)　**1b.** 术后轴向 T2 磁共振成像图像中对侧/同侧小关节平面长度的比值。术后比率为 0.94(12.53:13.32)。减少率为 5%[(0.99–0.94/0.99)×100%]

Fig. 1　Measurement of the length of facet joint plane and calculation of the ratio　**1a.** Calculation of the ratio of contralateral/ipsilateral facet joint plane length in axial T2 magnetic resonance imaging before operation was calculated. The ratio before operation was 0.99 (13.32:13.45)　**1b.** Ratio of contralateral/ipsilateral facet joint plane length in postoperative axial T2 magnetic resonance imaging images. The postoperative ratio was 0.94 (12.53:13.32). The reduction rate was 5% [(0.99–0.94/0.99)×100%]

异有统计学意义。

2　结果

2.1　临床疗效结果

本研究 33 例均获得随访，时间 12~18（14.9±2.3）个月，手术时间 47~65(56.10±5.19) min；术后患者的腰痛、腿痛 VAS 及 ODI 评分有明显的改善，与术前相比，末次随访时腰痛、腿痛 VAS 及 ODI 比较，差异均有统计学意义（P<0.05）。见表 1。根据改良 Macnab 标准：优 24 例，良 5 例，可 2 例，差 2 例。1 例术后出现脑脊液漏，给予患者头低脚高位，俯卧位并用盐袋盖压伤口，减少脑脊液渗出，患者末次随访时一般状况良好。

表 1　腰椎间孔狭窄症 33 例不同时间点 VAS 与 ODI 比较（$\bar{x}\pm s$）

Tab.1　Comparison of VAS and ODI at different time points of 33 patients with lumbar foraminal stenosis（$\bar{x}\pm s$）

时间	腰痛 VAS/分	腿痛 VAS/分	ODI/%
术前	7.273±1.442	7.697±1.447	69.82±9.74
术后 1 d	3.394±0.966^{a1}	2.818±0.727^{a2}	17.30±4.78^{a3}
末次随访	2.788±0.650^{b1}	2.394±0.704^{b2}	14.33±3.50^{b3}
F 值	170.6	275.8	742.4
P 值	<0.000 1	<0.000 1	<0.000 1

注：与术前比较，^{a1}t=17.31，P<0.000 1；^{a2}t=17.56，P<0.000 1；^{a3}t=25.27，P<0.000 1；^{b1}t=22.07，P<0.000 1；^{b2}t=17.91，P<0.000 1；^{b3}t=29.49，P<0.000 1

2.2　影像学结果

术后 MRI 扫描未观察到小关节侵犯和术后硬膜外血肿的发生。术前对侧/同侧小关节平面的比值为 0.97~0.99（0.98±0.02），术后比值为 0.91~0.96（0.94±0.03）。关节突关节面减少率约为 4.5%。在随访期间，动力位上没有出现新发展的节段性不稳定或腰椎滑脱。典型病例图片见图 2、图 3、图 4。

3　讨论

3.1　制定手术入路前应考虑的问题

DE ANTONI 等[11]于 1996 年首次报道了使用关节镜的双通道内镜手术。随后 UBE 技术逐渐兴起并用于腰椎退行性疾病[12–13]。UBE 手术的外科解剖结构与常规显微镜下腰椎间盘切除术相似，通过 4 mm 内窥镜放大病理病变，并通过持续生理盐水冲洗手术区域，可使手术解剖可视化[14–15]。而且，所有显微外科器械，如高速磨钻和 Kerrison 椎板咬骨钳也可用于 UBE 手术[16]。因此，与其他微创脊柱手术相比，UBE 手术被认为是具有相对较短学习曲线的微创技术[17–18]。尽管脊柱内窥镜手术和相关器械已经持续发展了几十年，但仍有一些挑战需要克服，如因小关节侵犯引起的医源性不稳定[14]。在同侧入路中，为了充分暴露手术术野，内侧小关节的侵犯是不可避免的。

3.2　UBE 下经对侧入路优势

WILTSE 等[19]于 1988 年简要描述了对侧入路作为腰椎开放手术入路的概念。据笔者所知，UBE 下通过对侧入路进行单侧减压的优点没有明确的描述。从解剖学角度来看，对侧入路更容易进入侧隐窝和椎间孔区域。由于同侧入路的可视化角度有限，术中可能需要切除部分小关节以接近侧隐窝或椎间孔区域。MATSUMURA 等[20]得出结论，在使用管状牵开器进行显微镜下减压时，$L_{4,5}$ 椎管狭窄的同侧和对侧小关节的保留率分别为 85.1%和 95.9%。单轴内窥镜下减压[21–22]和 UBE 下减压手术也报告了类似的结果，尤其是对于上腰椎的椎管狭窄症[23]。UBE 下同侧减压时，由于操作轨迹为垂直方向，因此需要切除更多的外侧关节面，然后才能切除内侧小关节以暴露侧隐窝。与显微镜下对侧单纯减压相比，UBE 对

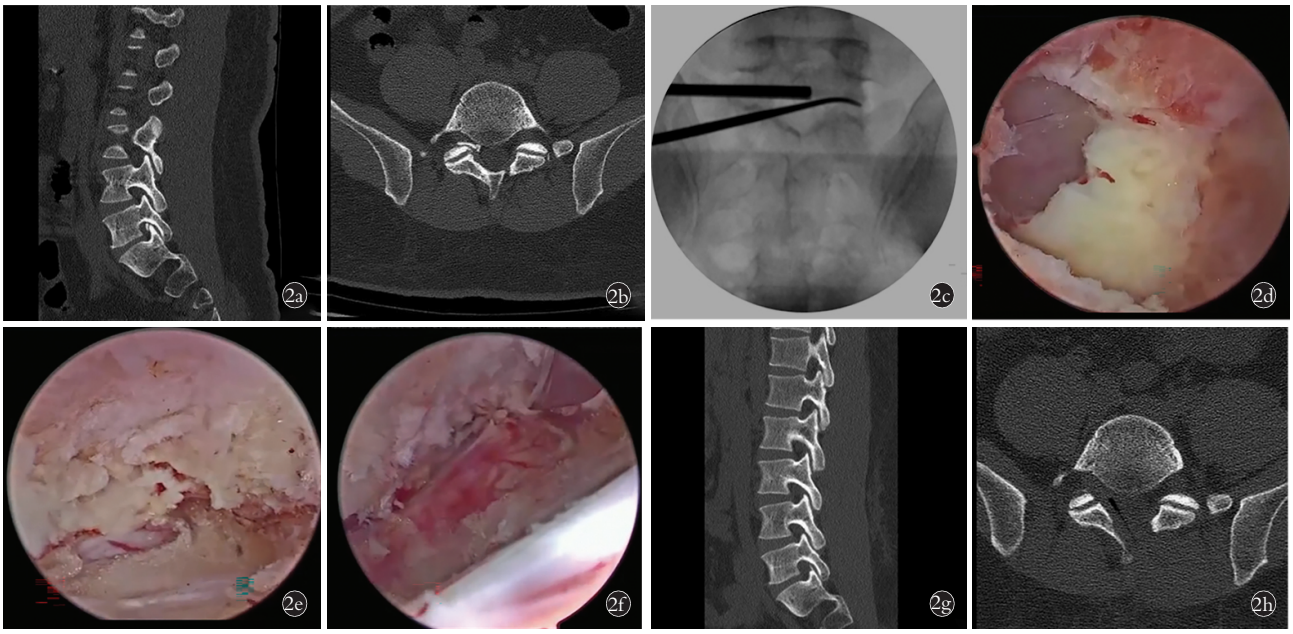

图 2　患者，男，36 岁，L_5S_1 右侧椎间孔狭窄症　**2a，2b.** 术前腰椎 CT 示 L_5S_1 右侧椎间孔狭窄　**2c.** 术中 X 线片示操作通道可到达对侧椎间孔区域　**2d.** 黄韧带近端止点　**2e，2f.** 术中骨块显露及对侧神经根减压完成后影像　**2g，2h.** 术后 1 d CT 显示骨性结构充分去除，椎间孔减压充分

Fig.2　A 36-year-old male patient with L_5S_1 right foraminal stenosis　**2a，2b.** Preoperative CT showed L_5S_1 right foraminal stenosis　**2c.** Intraoperative X-ray image showed that the operation channel could reach the contralateral foraminal area　**2d.** Proximal end of ligament flavum　**2e，2f.** During the operation the bone fragment was exposed and the contralateral nerve root was decompressed　**2g，2h.** At 1 day after operation，CT showed that adequate removal of bony structures and adequate foraminal decompression

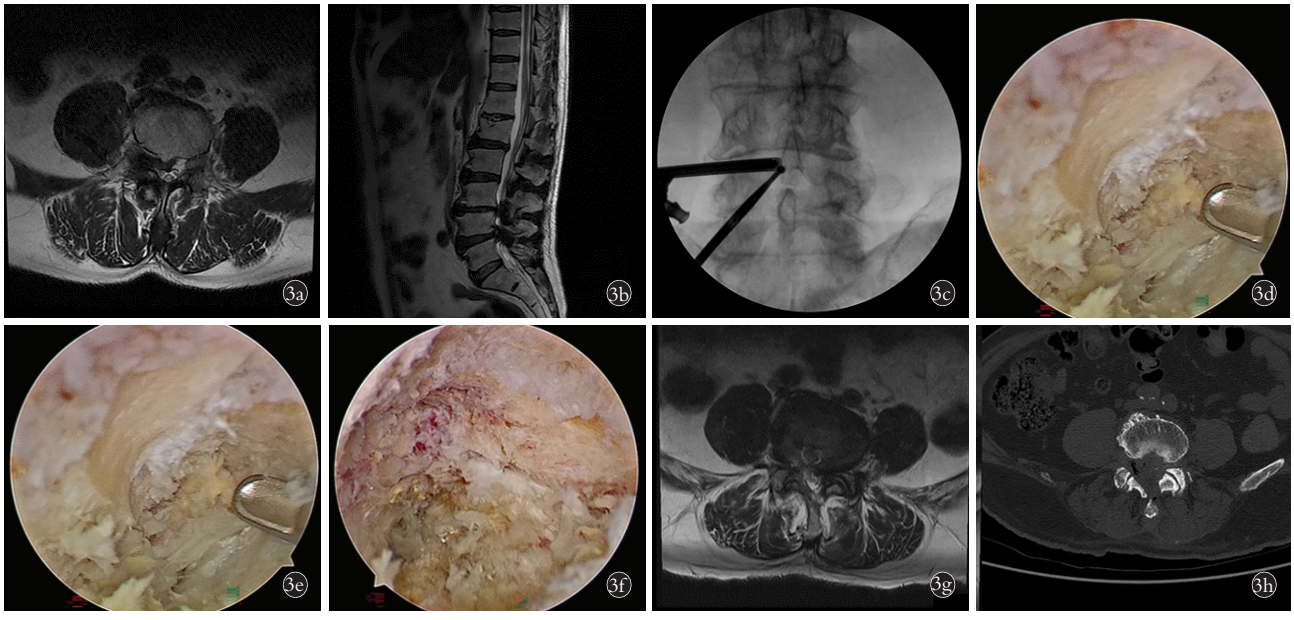

图 3　患者，男，72 岁，$L_{4,5}$ 右侧椎间孔狭窄症　**3a，3b.** 术前腰椎 MRI 示 $L_{4,5}$ 右侧椎间孔狭窄，黄韧带肥厚、增生、小关节内聚　**3c.** 术中 X 线影像操作通道定位图　**3d.** 术中对侧椎间孔区域黄韧带　**3e，3f.** 术中显露对侧出口根及对侧神经根减压完成后影像　**3g，3h.** 术后 1 d 复查 MRI、CT 示关节突内侧部分切除，黄韧带部分切除，对侧神经根松解，椎间孔扩大

Fig.3　A 72-year-old male patient with $L_{4,5}$ right foraminal stenosis　**3a，3b.** Preoperative lumbar MRI showed right foraminal stenosis in the $L_{4,5}$，yellow ligament hypertrophy，hyperplasia and cohesion of small joints　**3c.** Intraoperative X-ray image showed the specific position after completion of the work tube　**3d.** Intraoperative contralateral foraminal ligamentum flavum　**3e，3f.** Intraoperative ENR were found after removal of the attached LF and the decompression is completed　**3g，3h.** At 1 day after operation，MRI and CT showed that the medial part of the articular process was removed，the part of yellow ligament was removed，contralateral nerve root realse and the foraminal was enlarged

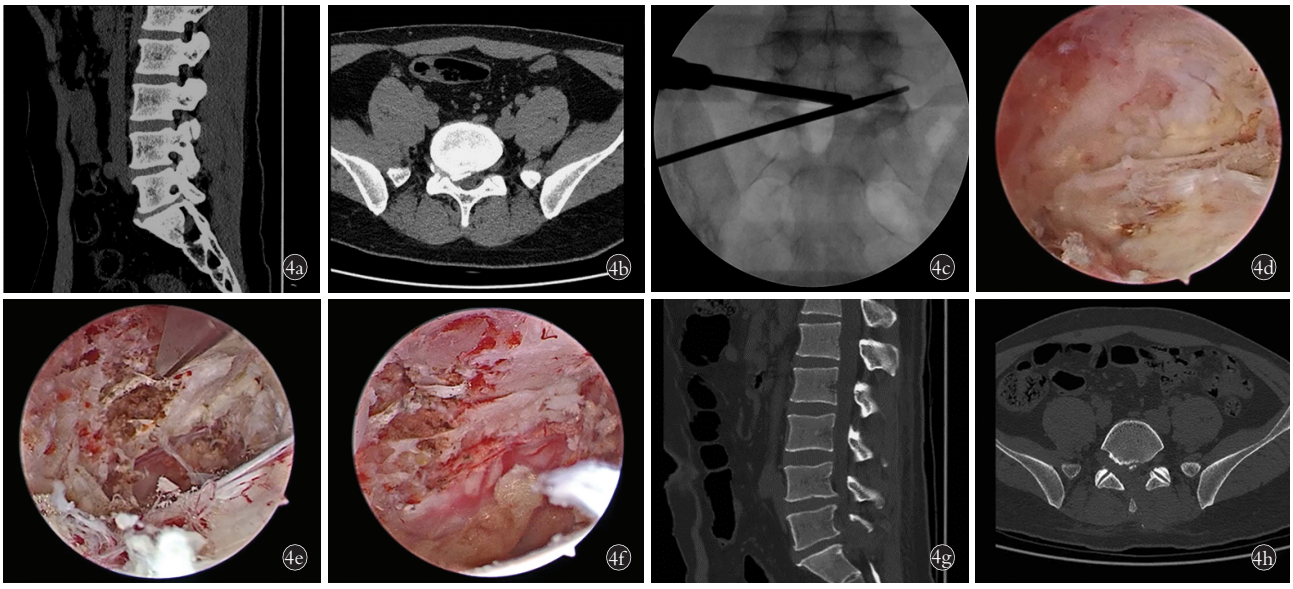

图 4　患者，男，36 岁，L_5S_1 椎间孔狭窄症　**4a，4b.** 术前腰椎 CT 示 L_5S_1 右侧椎间孔狭窄　**4c.** 术中 X 线片示操作通道可至椎间孔外　**4d.** 术中显示椎间孔区域骨赘　**4e，4f.** 去除对侧骨赘显露对侧出口根及对侧神经根减压完成后　**4g，4h.** 术后 1 d CT 示椎间孔减压充分

Fig.4　A 36-year-old male patient with L_5S_1 right foraminal stenosis　**4a, 4b.** Preoperative CT showed L_5S_1 right foraminal stenosis　**4c.** Confirmation of the extent of decompression through intraoperative X-ray images　**4d.** Visualization contralateral foraminal osteophytes　**4e, 4f.** Foraminal herniated disc and compressed ENR were found after removal of the superior-medial part of the superior articular process (SAP) and attached LF　**4g, 4h.** At one day after operation, CT showed that the foraminal was enlarged

侧入路可在不倾斜患者体位的情况下完成上关节突切除，并实现关节突关节的保留[24]。显微镜下单侧椎板切开双侧减压术中，对侧入路时，小关节的侵犯比同侧入路小。经同侧入路的小关节面积减少率约为 22.6%，下关节突骨折也报告为 6%[25]。在上腰椎病变、椎管狭窄和关节突关节矢状面形态的患者中，减压过程中关节突关节损伤的可能性已被高度报道。为了避免椎板切除术后关节突关节侵犯引起的腰椎医源性不稳定，一些学者尝试了 UBE 下对侧入路治疗腰椎间盘突出症并得到了良好的临床和手术结果[23,26]。PARK 等[27]研究表明 UBE 下经对侧入路小关节突关节面减少率约为 4.9%，低于早期报道的同侧入路关节面的切除率。笔者研究结果表明 UBE 下经对侧入路小关节突关节面减少率约为 4.5%，术后随访未见新发展的节段性不稳定或腰椎滑脱。这一事实表明，UBE 经对侧入路可能是完成侧隐窝以及椎间孔区域减压并保留关节突关节的首选手术方案。

对侧或同侧入路的选择取决于每个患者的脊柱解剖和病理。在轴向 CT 或 MRI 成像中，通过椎体或椎间盘中心和棘突关节中心绘制中矢状参考线。它作为术前棘突偏差和不对称椎板取向的参考线[28]，其中病理侧结构可能阻碍同侧入路，如棘间韧带骨化、关节突关节病骨赘形成、同侧棘突倾斜、退行性脊柱侧凸伴凹侧狭窄。从正常侧入路可能在技术上更容易，病理结构限制更少，并镜下更好地解剖识别组织结构。HEO 等[26]采用 UBE 经对侧入路治疗椎管内囊肿并得到良好的临床结果。

3.3　UBE 下经对侧入路手术技巧

UBE 手术工作起始点位于棘突与椎板交界处，该处没有附着肌肉及血管供应。保留椎旁肌和关节突关节，特别是病理侧，是非融合内镜脊柱手术最重要的考虑因素。在笔者所描述的对侧入路中，病理侧的椎旁肌肉以及关节突损伤较小。在 AHN 等[29]的研究中，患者行 ULBD 术后即刻 MRI 扫描中发现与手术时间相关的同侧和对侧的肌肉信号变化显著。在 2 周的随访中，同侧多裂肌的信号强度比（signal intensity ratio，SIR）增加了 52%，而对侧增加了 24.7%。由于多裂肌由脊神经背内侧支单节支配，同侧入路中侧向侧隐窝及椎间孔区域器械损伤脊神经背内侧支的风险更高，对侧入路可有效降低术后多裂肌失神经支配[30]。

本研究结果表明经 UBE 下经对侧入路治疗 FLS 患者术后临床结果显著改善，该结果与传统开放性椎间孔切开术和显微镜下椎间孔切除术的研究结果相似[31-32]。传统开放性椎间孔切开术的成功率为 76.9%~80.6%，使用经皮内镜腰椎间盘切除术进行椎间孔减压术的研究报告了几种神经系统并发症[33-34]，包括术后足下垂。本研究结果显示术后未出现神经系统相关并发症。此外，在常规开放性椎间孔减压术的研究中报道了一些并发症，如虚弱、血肿，

且手术时间(127~156 min)比本研究手术时间长。

综上，笔者认为 UBE 经对侧入路治疗腰椎间孔狭窄症在充分减压椎间孔区域的同时也能避免对腰椎稳定性产生影响，可作为治疗 LFS 的一种手术入路方式。

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