·脊柱脊髓疾病·

微创经椎间孔腰椎间融合术联合经皮螺钉内固定融合术治疗退行性腰椎滑脱

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【摘要】 **目的** 探讨微创经椎间孔腰椎间融合术(MIS-TLIF)联合经皮螺钉内固定融合术治疗退行性腰椎滑脱的临床疗效。**方法** 采用MIS-TLIF联合经皮螺钉内固定融合术共治疗32例退行性腰椎滑脱患者,比较术前和术后1周、3个月、末次随访时视觉模拟评分(VAS)、Oswestry功能障碍指数(ODI)和36条简明健康状况调查表(SF-36)评分,以及X线测量腰椎前凸角、冠状位Cobb角、冠状位和矢状位躯干偏移、腰椎滑脱程度(Meyerding分度)并计算滑脱率,X线或CT判断椎体融合率,MRI评价减压程度。**结果** 32例患者平均手术时间160 min,术中出血量120 ml,住院时间7.22 d,术后随访10.83个月。手术融合41个椎体节段,范围覆盖L_2~S_1节段。与术前相比,术后1周、3个月和末次随访时VAS(均P=0.000)和ODI(均P=0.000)评分增加,SF-36评分减少(P=0.002,0.000,0.000),腰椎前凸角(均P=0.000)、冠状位Cobb角(均P=0.000)和滑脱率(均P=0.000)均减小。至末次随访时,ODI改善率为(80.51±6.02)%,椎体融合率达92.22%且螺钉位置均良好。32例患者中1例术后感染、2例脑脊液漏,经对症治疗均痊愈;无一例发生神经功能缺损等严重并发症、内固定失败、椎弓根螺钉和钛棒断裂或Cage移位,无一例死亡。**结论** MIS-TLIF联合经皮螺钉内固定融合术创伤小、术中出血量少、并发症轻微、复位效果好、疗效确切,尽管存在手术时间较长、学习曲线较长、术中X线照射量较大等缺点,但仍是治疗退行性腰椎滑脱的有效方法。

【关键词】 脊椎滑脱; 腰椎; 脊柱融合术; 内固定术(非*MeSH*词); 外科手术,微创性

Treatment of degenerative lumbar spondylolisthesis by using minimally invasive transforaminal lumbar interbody fusion and percutaneous pedicle screw fixation

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【**Abstract**】 **Objective** To discuss clinical therapeutic effects of minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) combined with percutaneous pedicle screw fixation for degenerative lumbar spondylolisthesis (DLS). **Methods** A total of 32 DLS patients treated by MIS-TLIF and percutaneous pedicle screw fixation from January 2013 to September 2015 in Xuanwu Hospital, Capital Medical University were retrospectively reviewed. Visual Analogue Scale (VAS), Oswestry Disability Index (ODI) and Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) scores were assessed and compared between preoperation and one week, 3 months after operation and in the last follow-up. Lumbar lordosis angle, coronal Cobb angle, coronal and sagittal body shifting, complication, the degree of spondylolisthesis (Meyerding classification) and the rate of spondylolisthesis were measured according to preoperative and postoperative spinal X-ray examination. Fusion rate was evaluated according to X-rays or CT in the last follow-up, and MRI was used to assess the degree of decompression. **Results** Thirty-two patients were under test with mean operation time 160 min, intraoperative blood loss 120 ml, postoperative hospital stay 7.22 d and follow-up 10.83 months. Decompression and fusion levels ranged from L_2–S_1 and interbody fusion was performed in 32 patients and 41 levels were fused. Compared with preoperation, the VAS and ODI scores were significantly increased at one week, 3 months after operation and in the last follow-up (P=0.000, for all), while SF-36 score (P=0.002, 0.000, 0.000), lumbar lordotic angle (P=0.000,

doi:10.3969/j.issn.1672-6731.2016.03.003

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for all), coronal Cobb angle (P = 0.000, for all) and slippage rate (P = 0.000, for all) were significantly decreased. The fusion rate was 92.22%, and the improvement rate of ODI was (80.51 ± 6.02)% in the last follow-up. There were 3 cases appeared complications, including one case of infection and 2 cases of cerebrospinal fluid (CSF) fistula, and were cured after treatment. Neurological defects, internal fixation failure, breakage of pedicle screw or titanium rod, or Cage displacement were not found in 32 cases. There was no death. **Conclusions** MIS-TLIF combined with percutaneous pedicle screw fixation is an effective technique for treatment of DLS patients, with less injury, less intraoperative blood loss, low complication incidence rate, good scoliosis correction and definite therapeutic effects, even this method needs more operation time, longer learning curve and more radiation.

【**Key words**】 Spondylolysis; Lumbar vertebrae; Spinal fusion; Internal fixation (not in *MeSH*); Surgical procedures, minimally invasive

随着全球人口的老龄化，退行性腰椎滑脱（DLS）成为脊柱外科常见病之一。该病于1930年由Junghanns等首次报告，由于通常不伴腰椎峡部裂（lumbar spondylolysis），故又称之为假性滑脱[1]。至20世纪50年代，Macnab[2]和Newman[3]进一步描述该病相关临床表现。退行性腰椎滑脱是由于腰椎间盘和关节退行性变引起的存在完整神经弓的椎体滑移，常伴椎管狭窄，临床主要表现为腰部疼痛、间歇性跛行和下肢放射痛。多数患者仅采取保守治疗，约30%患者予手术治疗。目前，退行性腰椎滑脱手术方式较多，且存有争议[4-5]。近年来，首都医科大学宣武医院神经外科采用微创经椎间孔腰椎间融合术（MIS-TLIF）联合经皮螺钉内固定融合术治疗32例退行性腰椎滑脱患者，回顾其临床过程，探讨MIS-TLIF联合经皮螺钉内固定融合术的技术特点及其治疗退行性腰椎滑脱的有效性和安全性。

资料与方法

一、临床资料

选择2013年1月–2015年9月在首都医科大学宣武医院神经外科行MIS-TLIF联合经皮螺钉内固定融合术治疗的退行性腰椎滑脱患者共计32例，男性13例，女性19例；年龄49～83岁，平均72岁；病程2～10年，平均4.31年；临床主要表现为腰部疼痛32例、间歇性跛行28例、神经根症状30例；体格检查单侧下肢肌力减退1例、单侧或双侧下肢感觉异常10例、踝反射和膝反射异常各2例、Lasegue征阳性5例。本组患者均无骨骼成熟前脊柱侧弯、脊柱肿瘤、脊柱骨折、脊柱感染等病史。术前腰椎正侧位和过伸过屈位X线显示，Meyerding分度（腰椎滑脱）Ⅰ度25例、Ⅱ度7例，伴脊柱侧弯和旋转3例；腰椎前凸角（侧位X线示T_{12}椎体上终板与S_1椎体上终板所成夹角）0°～22°，中位值15.50°；冠状位Cobb角（正位X线示脊柱侧弯上下两端倾斜角度最大椎体所成夹角）5°～25°，中位值14°；躯干偏移冠状位5～20 mm、中位值10.23 mm，矢状位8～33 mm、中位值21.50 mm。腰椎CT和MRI检查均无中央型椎管狭窄。视觉模拟评分（VAS）5～9分，平均为（6.91 ± 1.22）分；Oswestry功能障碍指数（ODI）31～74分，平均为（52.73 ± 10.62）分；36条简明健康状况调查表（SF-36）评分60.00～89.90分，平均（75.62 ± 7.74）分。

二、研究方法

1. 手术方法 所有患者均行MIS-TLIF联合经皮螺钉内固定融合术。患者全身麻醉，俯卧位，X线定位手术椎体节段的体表标记及其椎弓根投影。于腰背部定位病变椎体体表标记后，沿正中线切开皮肤和皮下组织，沿深筋膜表面向两侧分离皮下组织至棘突旁开约3 cm。根据术前影像学资料选择椎体减压侧别，通常以症状较重一侧作为减压侧。分离减压侧椎旁肌上下范围约3 cm，外侧至病变椎体上下关节突关节。采用Quadrant通道微创手术系统（美国Medtronic公司）撑开，显露术野，手术显微镜下切除上下关节突内侧面，显露病变椎间盘。切除侧隐窝内黄韧带，行神经根管扩大，必要时需切除对侧黄韧带，行侧隐窝减压，切开病变椎体外侧纤维环，切除椎间盘髓核和上下终板软骨（http://www.cjcnn.org/index.php/cjcnn/pages/view/v1631）。将铰刀（由小至大）逐级置入椎间隙，通过相应拭模撑开椎间隙，植入自体骨或同种异体骨，再将填压颗粒骨的椎间融合器（Cage）植入椎间隙，要求Cage头端过中线，达椎体深部2/3，使Cage达到足够高度以恢复椎间隙高度，以利于滑脱复位。病变椎体节段减压和Cage植入后，彻底止血，缝合肌肉和深筋膜。在“C”型臂X线标准正位像引导下植入经皮椎

弓根螺钉，将预弯的钛棒植入皮下。根据患者术前胸椎后凸和腰椎前凸角度折弯钛棒，保持良好的腰椎前凸，防止术后脊柱矢状位失衡；若患者同时伴冠状位失衡，应以适当力度进行凹侧撑开、凸侧加压、椎体去旋转以矫正腰椎侧弯畸形。复位满意、固定稳妥后置入引流管，逐层缝合皮下组织和皮肤。术后48～72 h拔除引流管，术后48 h开始下肢肌肉训练，术后1周可在胸腰支具保护下离床活动。

2.评价指标 （1）临床指标：包括手术时间、术中出血量、住院时间和术后并发症，以及术前和术后1周、3个月、末次随访时VAS、ODI和SF-36评分。计算ODI改善率[改善率（%）=（1－术后ODI/术前ODI）×100%]，改善率＞75%为优，50%～75%为良，25%～49%为可，＜25%为差[6]。（2）影像学指标：分别于术前和术后1周、3个月、末次随访时行腰椎X线、CT和MRI检查，X线测量腰椎前凸角、冠状位Cobb角（冠状位失衡时）、冠状位和矢状位躯干偏移、腰椎滑脱程度（Meyerding分度）并计算滑脱率[滑脱率（%）=椎体滑移距离/椎体下缘长度×100%[7]]，Meyerding分度Ⅰ度为滑脱＜25%，Ⅱ度为滑脱达25%～50%，Ⅲ度为滑脱达51%～75%，Ⅳ度为滑脱达76%～100%，Ⅴ度为滑脱＞100%即椎体脱离[8]。X线或CT判断椎体融合率，MRI评价减压程度。

三、统计分析方法

采用SPSS 16.0统计软件进行数据处理与分析。呈正态分布的计量资料以均数±标准差（$\bar{x} \pm s$）表示，手术前后VAS、ODI和SF-36评分的比较，采用单因素方差分析，两两比较行LSD-t检验；呈非正态分布的计量资料以中位数和四分位数间距[$M(P_{25}, P_{75})$]表示，手术前后腰椎前凸角、冠状位Cobb角、滑脱率的比较采用Friedman秩和检验，两两比较行Mann-Whitney U检验。以$P \leq 0.05$为差异具有统计学意义。

结　果

本组32例患者手术融合41个椎体节段，范围覆盖L_2～S_1节段，其中$L_{4\sim5}$节段融合25例、L_5～S_1节段3例、$L_{3\sim5}$节段2例、L_4～S_1节段1例、$L_{2\sim5}$节段1例（图1）。手术时间120～220 min，平均160 min。术中出血量100～500 ml，平均120 ml；其中1例采用自体血回输，余31例采用控制性降压方法维持收缩压于100～110 mm Hg（1 mm Hg=0.133 kPa）以减少术中出血。住院时间5～10 d，平均7.22 d。与术前相比，术后1周、3个月和末次随访时VAS（均P=0.000）和ODI（均P=0.000）评分增加，SF-36评分减少（P=0.020，0.000，0.000），腰椎前凸角（均P=0.000）、冠状位Cobb角（均P=0.000）和滑脱率（均P=0.000）均减小（表1，2）。

本组患者术后随访3～24个月，平均10.83个月。至末次随访时，ODI改善率67.30%～90.53%，平均（80.51±6.02）%；术后X线或CT评价椎体融合率达92.22%，且螺钉位置良好。32例患者中1例出现术后感染，予广谱抗生素治疗和手术切口积极换药后治愈；2例发生脑脊液漏，予漏口缝合和加压包扎后治愈；无一例发生神经功能缺损等严重并发症，无一例内固定失败，无一例出现椎弓根螺钉和钛棒断裂或Cage移位。本组无死亡病例。

讨　论

脊柱退行性变最初发生于椎间盘，继而导致一系列改变，如椎间隙狭窄、黄韧带肥厚、椎体骨赘形成、软骨下硬化、关节突关节增生、出现“显微不稳定（microinstability）”等。脊柱退行性变可以表现为矢状位节段性不稳，亦可以表现为冠状位侧方滑脱即脊柱侧弯，或二者并存。退行性腰椎滑脱好发于50岁以上人群，女性发病率为男性4倍，最常发生部位为$L_{4\sim5}$节段。其发生与多种因素有关，其中妊娠、全身关节松弛和卵巢切除是女性发病的主要原因，此外，关节突关节面出现矢状位移位、扩大的椎弓根与关节突出现夹角亦是其发病的重要因素。Iguchi等[4]报告201例退行性脊柱滑脱患者，其中单个椎体节段滑脱132例（65.67%），包括93例（70.45%）椎体前滑脱和39例（29.55%）椎体后滑脱，前者以女性为主，主要发生于$L_{4\sim5}$节段，后者无性别差异，主要发生于$L_{2\sim3}$节段；多个椎体节段滑脱69例（43.33%），以2个节段为主。退行性腰椎滑脱通常呈现3种临床症状：（1）神经源性间歇性跛行。由于椎体滑脱、黄韧带增厚、关节突增生致骨赘形成，突入椎管造成继发性椎管狭窄所致。疼痛可沿臀部、下肢向远端放射，多伴下肢麻木、无力，站立或行走时显著，休息或脊柱前屈时缓解。应注意与血管源性间歇性跛行相鉴别。（2）神经根性疼痛。侧隐窝或椎间孔狭窄致神经根受压，继而出现该神经支配区域感觉和运动障碍。疼痛由神经根机械性压迫或炎性介质刺激所引发。（3）机械性下腰痛。下腰

图1　女性患者，56岁，主诉双侧腰部疼痛5年、间歇性跛行3个月，临床诊断为退行性腰椎滑脱，行MIS-TLIF联合经皮螺钉内固定融合术。手术前后腰椎影像学检查所见　1a，1b　术前正位和侧位X线显示，L_2节段向后呈Ⅰ度滑脱（箭头所示），滑脱率9.50%，椎体前缘连线不连续且呈阶梯样改变，L_{2-3}椎间隙变窄，椎体边缘可见骨质增生　1c　术前过伸位X线显示，L_2节段向后滑移增大（箭头所示）　1d　重建矢状位CT显示L_2节段向后滑移（箭头所示），L_{2-3}椎间隙变窄，椎体边缘骨质增生　1e　术前矢状位T_1WI显示，L_2节段向后滑移，L_{2-3}椎间隙变窄、椎间盘突出（箭头所示）　1f　术前矢状位T_2WI显示，L_2节段向后滑移，L_{2-3}椎间隙变窄、椎间盘突出（箭头所示）　1g，1h　术后6个月正位和侧位X线显示，L_{2-5}节段固定融合，螺钉位置良好，L_2节段滑脱改善，复位率72.12%

Figure 1　A 56-year-old female patient complained of 5 years of bilateral lumbar pain and intermittent claudication for 3 months, and was diagnosed as DLS. She underwent MIS-TLIF combined with percutaneous pedicle screw fixation. Lumbar imaging findings before and after operation　Preoperative orthophoric and lateral X-ray examination showed that L_2 was Ⅰ degree of backward (arrows indicate), and the slippage rate was 9.50%. The leading edge of vertebral body, in the shape of ladder steps, was not continuous. L_{2-3} intervertebral space was narrowed, and bone hyperplasia was apparent in the edge of vertebral body (Panel 1a, 1b). Preoperative hyperextension X-ray showed that L_2 backward slipping distance was increased (arrow indicates, Panel 1c). Reconstructed sagittal CT showed L_2 backward slippage (arrow indicates) and intervertebral narrowing at L_{2-3} and bone hyperplasia in the edge of vertebral body (Panel 1d). Preoperative sagittal T_1WI (Panel 1e) and T_2WI (Panel 1f) showed L_2 backward slippage and intervertebral narrowing and disc protrusion at L_{2-3}, but no stenosis in this spinal canal (arrows indicate). The orthophoric and lateral X-ray 6 months after operation showed that L_{2-5} fixed bone fusion had been achieved, the position of screws was good. L_2 slippage was improved, and the reduction rate was 72.12% (Panel 1g, 1h).

痛和臀部、大腿后部牵涉痛可能源于椎间盘和关节突关节退行性变。典型表现为患者由弯腰状态直腰时突然出现腰部“被逮住”样疼痛（catching pain）。研究显示，机械性下腰痛主要是椎间盘退行性变和髓核脱水后椎体终板承载分布异常所致[4]。

多数退行性腰椎滑脱患者无临床症状或临床

表1 本组患者手术前后临床和影像学指标的比较($\bar{x} \pm s$)

Table 1. Comparison of clinical and imaging indexes before and after operation ($\bar{x} \pm s$)

Time	N	VAS (score)	ODI (score)	SF-36 (score)	Lumbar lordotic angle (°)	Coronal Cobb angle (°)	Slippage rate (%)
Preoperation (1)	32	6.91 ± 1.22	52.73 ± 10.62	75.62 ± 7.74	15.50 (11.25, 20.00)	14.00 (11.25, 18.00)	14.10 (9.35, 23.48)
1 week after operation (2)	32	5.42 ± 1.53	40.74 ± 7.51	78.53 ± 8.31	3.00 (2.00, 4.00)	5.00 (3.25, 6.00)	2.00 (1.05, 2.38)
3 months after operation (3)	32	2.10 ± 0.81	18.52 ± 5.50	104.62 ± 7.31	3.00 (2.00, 4.00)	5.00 (4.00, 6.00)	2.00 (1.00, 2.20)
The latest follow-up (4)	32	1.53 ± 0.64	10.14 ± 3.31	113.60 ± 6.21	3.00 (2.00, 4.75)	5.00 (4.00, 6.00)	2.00, (1.00, 2.00)
Statistical value		88.309	91.495	47.360	76.793	71.376	77.405
P value		0.000	0.000	0.000	0.000	0.000	0.000

ANOVA test for comparison of VAS, ODI and SF-36, and Friedman rank sum test for others。VAS, Visual Analogue Scale, 视觉模拟评分; ODI, Oswestry Disability Index, Oswestry功能障碍指数; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey, 36条简明健康状况调查表。The same for Table 2

表2 本组患者手术前后临床和影像学指标的两两比较

Table 2. Paired comparison of clinical and imaging indexes before and after operation

Paired comparison	VAS		ODI		SF-36		Lumbar lordotic angle		Coronal Cobb angle		Slippage rate	
	t value	*P* value	*t* value	*P* value	*t* value	*P* value	*U* value	*P* value	*U* value	*P* value	*U* value	*P* value
(1) : (2)	25.444	0.000	6.656	0.000	-2.457	0.020	400.500	0.000	1546.000	0.000	0.000	0.000
(1) : (3)	17.756	0.000	17.112	0.000	-18.349	0.000	166.500	0.000	686.000	0.000	0.000	0.000
(1) : (4)	22.413	0.000	23.613	0.000	-30.112	0.000	126.500	0.000	509.000	0.000	0.000	0.000

症状轻微,仅需保守治疗即可[5-6]。Matsunaga等[9]报告157例腰椎滑脱患者,其中40例采取保守治疗,男性11例、女性29例,初诊为$L_{4\sim5}$椎体滑脱35例(87.50%)、$L_5\sim S_1$椎体滑脱4例(10%)、$L_{3\sim4}$椎体滑脱1例(2.50%),随访≥5年,滑脱率7~28%,平均13.60%,其中7例(17.50%)滑脱率<10%,29例(72.50%)滑脱率10%~19%,4例(10%)滑脱率≥20%。12例患者滑脱进行性加重,13例患者椎体终板钙化伴韧带骨化,随访观察证实滑脱均不再加重,因此将椎体终板钙化伴韧带骨化视为滑脱趋于稳定的标志。目前推荐的手术指征为[7]:(1)保守治疗3个月以上,仍有持续性或反复性腰腿痛或神经源性间歇性跛行,且严重影响生活质量。(2)神经功能缺损进行性加重。(3)存在马尾神经损害症状。手术方式包括早期单纯椎板减压术、椎板减压联合椎体融合术、椎板减压联合内固定融合术,以及目前的微创减压术联合内固定融合术和腰椎非融合技术Dynesys系统等多种方式。单纯椎板减压术可解除椎体滑脱造成的神经根压迫、缓解神经功能缺损症状,但长期疗效尚不肯定。国外文献报道的临床满意度差异较大(60%~96%),且遗留腰部疼痛的比例达73%[5-7,9]。20世纪80年代,Lombardi等[10]和Johnsson等[8]采用单纯椎板减压术治疗退行性脊柱滑脱的疗效相近,但均不甚理想,建议联合椎体融合术以提高疗效,表明单纯椎板减压术可以有效解除椎管狭窄的原因,但不能恢复椎体稳定性,甚至可能进一步加重椎体失稳。因单纯椎板减压术后腰痛发生率较高,多数学者推荐椎板减压术联合椎体融合术治疗退行性腰椎滑脱伴椎管狭窄[7-9]。但是对于Ⅰ度滑脱且以间歇性跛行为主要表现的高龄患者而言,单纯椎板减压术仍是有效治疗方法之一[10]。1991年,Herkowitz和Kurz[12]开展一项前瞻性临床研究,对采用单纯椎板减压术或椎板减压术联合原位椎体融合术治疗的50例退行性腰椎滑脱伴椎管狭窄患者的随访结果进行比较,平均随访3年,结果显示,减压联合融合组患者腰部疼痛缓解率高于单纯减压组($P=0.001$),且未见明显滑脱进展;单纯减压组患者局部骨质增生明显,导致椎管和神经根管狭窄,而减压联合融合组患者骨重塑少见,表明椎体融合可以有效防止椎管狭窄复发。随着内固定技术和材料的发展,脊柱内固定术广泛应用于腰椎失稳的治疗。目前对采用脊柱内固定术治疗峡部裂性椎体滑脱的意见较为一致,但对退行性脊柱滑脱伴椎管狭窄是否采用内固定术尚存争议,其争论的焦点为:(1)是否必须采用内固定术。(2)内固定术可以提高椎体融合率,但是否可同时

提高临床满意度。(3)内固定术具有潜在危险性。(4)内固定术费用昂贵。众多研究者对此进行了较为详尽的描述,例如Bridwell等[13](1993年)、Yuan等[14](1994年)、Booth等[15](1999年)、Fischgrund[16](2004年)和Kornblum等[17](2004年)分别报告其研究结果,与单纯减压组相比,减压联合融合组患者椎体融合率提高($P=0.001$)、融合速度增快($P=0.001$)。目前普遍认为,退行性腰椎滑脱的主要治疗目标是减压以缓解神经功能缺损症状,椎体融合之目的是通过稳定椎体以缓解疼痛,故应用器械固定有助于提高椎体融合率、矫正滑脱和侧弯畸形。与原位椎体融合术相比,滑脱复位能否产生更佳的临床疗效尚待进一步验证,但复位可恢复椎体矢状位平衡,间接对椎间孔减压,从而提高手术疗效。滑脱复位的关键是恢复椎间隙高度,采用椎间融合器和椎间植骨进行椎间融合,并辅助椎弓根螺钉内固定。因此,减压术联合内固定融合术是目前治疗退行性腰椎滑脱的主要方法[12-17]。该术式的适应证为[16,18-19]:(1)椎间盘高度完全塌陷,运动节段有重新趋于稳定的倾向,滑脱进展的可能性较小[4],因此,如果术前椎间盘高度>2 mm,需防止滑脱进展。(2)当退行性滑脱使椎体节段前凸变小或后凸增大时,需恢复椎体前凸。(3)退行性滑脱与侧弯并存。(4)滑脱节段异常运动>5 mm。(5)滑脱率>50%。(6)既往行椎板切除术的患者,无论滑脱是否进展,同一椎体节段需减压。(7)相邻椎体节段退行性变致滑脱并出现临床症状,需减压。(8)为充分减压,双侧关节突关节切除>50%。(9)充分减压需切除椎弓根峡部。(10)预计滑脱进展不可避免。

应用内固定器械的弊端在于传统腰椎内固定术需广泛剥离椎旁肌,可引起椎旁肌缺血、失神经支配,进而导致肌萎缩和瘢痕化。部分患者术后可出现腰背部肌肉轴性疼痛、无力,症状复发甚至加重,称为腰椎术后失败综合征,可能与传统手术术中损伤腰椎椎旁肌有关[20-21]。因此,众多学者和工程师不断尝试发明新的内固定器械和微创内固定技术,Inoue等[22](1988年)和Satomi等[7](1992年)分别采用前路腰椎间融合术(ALIF)治疗退行性腰椎滑脱,获得较好疗效,表明通过恢复椎间隙高度可以间接达到减压和滑脱复位之目的,适用于早期病变。对于退行性变较为严重的患者,下位椎体上关节突骨赘是引起压迫的另一主要原因,仍推荐采用后入路术式。20世纪80年代,Magerl[23]采用经皮椎弓根螺钉外固定术治疗胸腰椎骨折和椎体滑脱,疗效较好,此后,随着该项技术和手术设备的不断改进和发展,MIS-TLIF得以实现[24-26]。与传统开放式TLIF相比,MIS-TLIF在手术显微镜下操作,可借助特殊工作通道完成,减压更彻底,可从一侧将对侧侧隐窝和神经根孔减压,减少神经根和硬脊膜囊损伤以及术中出血,避免传统使用内固定材料的弊端,疗效确切[12-17,24-26],但也存在学习曲线较长、早期手术时间较长、X线照射量较多等缺点。

结　论

仅30%的退行性腰椎滑脱患者需手术治疗,此类患者术前须予以严格的保守治疗。退行性腰椎滑脱的治疗原则为:(1)充分减压。(2)维持病变椎体节段的稳定性。(3)尽管目前对内固定融合术的适应证尚存争议,但越来越多的学者倾向于滑脱复位和重建矢状位平衡以利于改善长期预后。(4)微创内固定技术如MIS-TLIF具有一定优势,联合经皮椎弓根内固定融合术是一种治疗退行性腰椎滑脱安全而有效的方法。

参 考 文 献

[1] Sengupta DK, Herkowitz HN. Degenerative spondylolisthesis: review of current trends and controversies. Spine (Phila Pa 1976), 2005, 30(6 Suppl):71-81.

[2] Macnab I. Spondylolisthesis with an intact neural arch: the so-called pseudospon-dylolisthesis. J Bone Joint Surg Br, 1950, 32: 325-333.

[3] Newman PH. Spondylolisthesis, its cause and effect. Ann R Coll Surg Engl, 1955, 16:305-323.

[4] Iguchi T, Wakami T, Kurihara A, Kasahara K, Yoshiya S, Nishida K. Lumbar multilevel degenerative spondylolisthesis: radiological evaluation and factors related to anterolisthesis and retrolisthesis. J Spinal Disord Tech, 2002, 15:93-99.

[5] Winters JM, Herkowitz HN. Degenerative lumbar spondylolisthesis: evolution of treatment. Argospine News J, 2011, 23:3-9.

[6] Meyerding HW. Low backache and sciatic pain associated with spondylolistheais and protruded intervertebral disc: incidence, significance and treatment. J Bone Joint Surg Am, 1941, 23:461-470.

[7] Satomi K, Hirabayashi K, Toyama Y, Fujimura Y. A clinical study of degenerative spondylolisthesis: radiographic analysis and choice of treatment. Spine (Phila Pa 1976), 1992, 17:1329-1336.

[8] Johnsson KE, Willner S, Johnsson K. Postoperative instability after decompression for lumbar spinal stenosis. Spine (Phila Pa 1976), 1986, 11:107-110.

[9] Matsunaga S, Sakou T, Morizono Y, Masuda A, Demirtas AM. Natural history of degenerative spondylolisthesis: pathogenesis and natural course of the slippage. Spine (Phila Pa 1976), 1990, 15:1204-1210.

[10] Lombardi JS, Wiltse LL, Reynolds J, Widell EH, Spencer C 3rd. Treatment of degenerative spondylolisthesis. Spine (Phila Pa 1976), 1985, 10:821-827.
[11] Zou DW, Ouyang J, Ruan DK, Li FB, Zheng ZM, Zhang ZL. Discussion on problems in the treatment of lumbar spondylolisthesis. Zhongguo Ji Zhu Ji Sui Za Zhi, 2006, 16:7-10. [邹德威, 欧阳甲, 阮狄克, 李佛保, 郑召民, 张佐伦. 关于腰椎滑脱治疗中一些问题的讨论. 中国脊柱脊髓杂志, 2006, 16:7-10.]
[12] Herkowitz HN, Kurz LT. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective study comparing decompression with decompression and intertranverse process arthrodesis. J Bone Joint Surg Am, 1991, 73:802-808.
[13] Bridwell KH, Sedgewick TA, O'Brien MF, Lenke LG, Baldus C. The role of fusion and instrumentation in the treatment of degenerative spondylolisthesis with spinal stenosis. J Spinal Disord, 1993, 6:461-472.
[14] Yuan HA, Garfin SR, Dickman CA, Mardjetko SM. A historical cohort study of pedicle screw fixation in thoracic, lumbar, and sacral spinal fusion. Spine (Phila Pa 1976), 1994, 19(20 suppl): 2279-2296.
[15] Booth KC, Bridwell KH, Eisenberg BA, Baldus CR, Lenke LG. Minimum 5 - year results of degenerative spondylolisthesis treated with decompression and instrumented posterior fusion. Spine (Phila Pa 1976), 1999, 24:1721-1727.
[16] Fischgrund JS. The argument for instrumented decompressive posterolateral fusion for patients with degenerative spondylolisthesis and spinal stenosis. Spine (Phila Pa 1976), 2004, 29:173-174.
[17] Kornblum MB, Fischgrund JS, Herkowitz HN, Abraham DA, Berkower DL, Ditkoff JS. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective long - term study comparing fusion and pseudarthrosis. Spine (Phila Pa 1976), 2004, 29:726-733.
[18] Herkowitz HN. Degenerative lumbar spondylolisthesis: a surgeon's perspective of 30 years in practice. Spine J, 2010, 10: 916-917.
[19] Herkowitz HN, Abraham DJ, Albert TJ. Management of degenerative disc disease above an L_5 - S_1 segment requiring arthrodesis. Spine (Phila Pa 1976), 1999, 24:1268-1270.
[20] Kim KT, Lee SH, Suk KS, Bae SC. The quantitative analysis of tissue injury markers after mini - open lumbar fusion. Spine (Phila Pa 1976), 2006, 31:712-716.
[21] Kim DY, Lee SH, Chung SK, Lee HY. Comparison of multifidus muscle atrophy and trunk extension muscle strength: percutaneous versus open pedicle screw fixation. Spine (Phila Pa 1976), 2005, 30:123-129.
[22] Inoue SI, Watanabe T, Goto S, Takahashi K, Takata K, Sho E. Degenerative spondylolisthesis: pathophysiology and results of anterior interbody fusion. Clin Orthop Relat Res, 1988, 227:90-98.
[23] Magerl F. External skeletal fixation of the lower thoracic and lumbar spine. New York: Springer-Verlag, 1982: 353-366.
[24] Kotani Y, Abumi K, Ito M, Sudo H, Abe Y, Minami A. Mid-term clinical results of minimally invasive decompression and posterolateral fusion with percutaneous pedicle screws versus conventional approach for degenerative spondylolisthesis with spinal stenosis. Eur Spine J, 2012, 21:1171-1177.
[25] Kim CW, Siemionow K, Anderson DG, Phillips FM. The current state of minimally invasive spine surgery. J Bone Joint Surg Am, 2011, 93:582-596.
[26] Wang MY, Anderson DG, Ludwig SC, Mummaneni PV. Handbook of minimally invasive and percutaneous spine surgery. Boca Raton: CRC Press, 2011: 1-10.

（收稿日期：2016-02-01）

Systems Biology of Alzheimer's Disease published

Systems Biology of Alzheimer's Disease (ISBN: 978-1-4939-2626-8, eBook ISBN: 978-1-4939-2627-5) will be published by Humana Press in 2016. The editors of this book are Juan I. Castrillo and Stephen G. Oliver, Department of Biochemistry & Cambridge Systems Biology Centre, University of Cambridge, UK.

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