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·临床研究·

两种椎体间融合术对Ⅰ度腰椎滑脱症的疗效比较

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[摘 要] **目的** 对比脊柱内镜下经椎间孔腰椎椎体间融合术(Endo-TLIF)与微创经椎间孔入路腰椎椎体间融合术(MIS-TLIF)治疗Ⅰ度腰椎滑脱症的临床疗效。**方法** 选取2023年4月至2024年5月在我院接受手术治疗的30例单节段Ⅰ度腰椎滑脱症患者,根据手术方式不同,将其分为MIS-TLIF组(13例)和Endo-TLIF组(17例)。比较2组患者手术相关指标;分别采用视觉模拟量表(VAS)、Oswestry功能障碍指数(ODI)评估2组患者手术前后的疼痛情况及功能情况;比较2组患者滑脱复位率、术后椎间隙高度、节段融合率及并发症发生情况。**结果** Endo-TLIF组患者手术时间、术中透视次数均长/多于MIS-TLIF组($P<0.05$),术中出血量、术后总引流量和术后住院时间均明显少/短于MIS-TLIF组($P<0.05$)。Endo-TLIF组患者术后3 d、术后3个月、术后6个月的VAS评分均低于MIS-TLIF组;Endo-TLIF组患者术后3 d、术后3个月ODI评分高于MIS-TLIF组($P<0.05$),术后6个月ODI评分低于MIS-TLIF组($P<0.05$)。2组患者滑脱复位率、术后椎间隙高度及节段融合率比较,差异均无统计学意义($P>0.05$)。2组患者术后并发症总发生率比较,差异无统计学意义($P>0.05$)。**结论** Endo-TLIF与MIS-TLIF治疗Ⅰ度腰椎滑脱症均可获得较好的临床效果,但Endo-TLIF对近期预后的积极作用更明显。

[关键词] 腰椎滑脱症;经椎间孔腰椎椎体间融合术;微创经椎间孔入路腰椎椎体间融合术;临床疗效
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Comparison of the outcomes of two types of interbody fusion surgeries for grade Ⅰ lumbar spondylolisthesis

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Abstract: Objective To compare the clinical outcomes of endoscopic transforaminal lumbar interbody fusion (Endo-TLIF) versus minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) for grade Ⅰ lumbar spondylolisthesis. **Methods** A total of 30 patients with single-segment grade Ⅰ lumbar spondylolisthesis who underwent surgical treatment in our hospital from April 2023 to May 2024 were enrolled. According to the different surgical methods, they were divided into the MIS-TLIF group (n=13) and the Endo-TLIF group (n=17). The surgical-related indicators of both groups were compared. The pain levels and functional status of patients in the two groups before and after surgery were assessed by visual analogue scale (VAS) and Oswestry disability index (ODI). The slippage reduction rates, postoperative intervertebral space heights, segmental fusion rates, and incidences of complications were compared between the two groups. **Results** Endo-TLIF group had significantly longer operative time and more intraoperative fluoroscopy times than those in the MIS-TLIF group($P<0.05$),

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while the intraoperative blood loss, total postoperative drainage volume and postoperative hospital stay were significantly less/shorter compared with the MIS-TLIF group (P<0.05). Endo-TLIF group had significantly lower VAS scores at 3 days, 3 months, and 6 months postoperatively than those in the MIS-TLIF group (P<0.05). The ODI scores in the Endo-TLIF group were higher at 3 days and 3 months postoperatively, but lower at 6 months postoperatively compared with the MIS-TLIF group (P<0.05). No statistically significant differences were observed in the slippage reduction rates, postoperative intervertebral space heights, or segmental fusion rates between the two groups (P>0.05). Similarly, no statistically significant differences were found in the overall incidences of complications after surgery between the two groups (P>0.05). **Conclusion** Both Endo-TLIF and MIS-TLIF can achieve good clinical outcomes in the treatment of grade Ⅰ lumbar spondylolisthesis, while Endo-TLIF shows more pronounced positive effects on short-term prognosis.

Keywords: lumbar spondylolisthesis; transforaminal lumbar interbody fusion; minimally invasive transforaminal lumbar interbody fusion; clinical outcome

腰椎滑脱症是一种常见的脊柱疾病,不仅会导致腰椎结构不稳定,还可能压迫神经根或脊髓,从而引发一系列严重的临床症状[1-2]。Ⅰ度腰椎滑脱症是腰椎滑脱中最为常见的类型,多数患者经保守治疗无效后需接受手术干预,而手术方案的选择直接影响患者的术后生活质量与远期预后,因此针对该群体开展不同手术方式的对比具有临床指导意义。目前临床开展的椎体间融合术已逐步向微创化发展。椎体间融合术不仅能够缓解临床不适症状,还能够消除滑脱导致的不稳定性[3]。腰椎椎体间融合术囊括许多不同的术式,其中以后路腰椎椎体间融合术(posterior lumbar interbody fusion, PLIF)和经椎间孔腰椎椎体间融合术(transforaminal lumbar interbody fusion, TLIF)在骨科手术治疗中最为常用[4-5]。PLIF通过后路正中切口暴露椎间隙及两侧椎弓根,剥离椎旁肌肉,牵开神经根及硬膜囊,达到彻底减压的目的,但其创伤较大,术后恢复慢。TLIF通过单侧椎间孔入路,避免了后路正中切口带来的创伤,减少了椎旁肌肉的剥离,减小了对病变节段稳定性的影响,同时能有效减少脊髓损伤的风险,术后疼痛和康复的时间也随之明显缩短[6-7]。以TLIF为基础改良的微创经椎间孔入路腰椎椎体间融合术(minimally invasive transforaminal lumbar interbody fusion, MIS-TLIF)则能够在完成减压融合的同时进一步减轻手术对患者的损伤[8]。研究证实,与传统手术(如PLIF)比较,MIS-TLIF术后神经功能改善效果更好,且疼痛评分更低[9-10]。脊柱内镜下经椎间孔腰椎椎体间融合术(endoscopic transforaminal lumbar interbody fusion, Endo-TLIF)可以在脊柱内镜下扩大椎管容积、完整去除椎间盘和终板软骨、放置椎间融合器,同时以经皮椎弓根螺钉来进行固定[11]。但目前现有研究多聚焦于单一术式的安全性与有效性验证,少有研究直接针对Ⅰ度腰椎滑脱症群体对比两种微创术式的近远期疗效、影像学结果与并发症发生情况。因此,本研究对接受MIS-TLIF和Endo-TLIF治疗的Ⅰ度腰椎滑脱症患者的临床资料进行回顾性分析,明确两种术式的临床应用特点与效果差异,为此类患者临床术式的选择提供更贴合实际诊疗需求的参考依据。

1 资料与方法

1.1 临床资料

选取2023年4月至2024年5月在我院脊柱外科行L_4/L_5椎间融合椎弓根内固定术的30例L_4椎体Ⅰ度腰椎滑脱症患者为研究对象,依据手术方式的不同,将其分为Endo-TLIF组(17例)和MIS-TLIF组(13例)。Endo-TLIF组患者男7例、女10例,年龄(63.94±8.33)岁,病程(31.24±30.22)个月;MIS-TLIF组患者男5例、女8例,年龄(61.69±6.49)岁,病程(31.38±26.51)个月。2组患者性别、年龄、病程比较,差异无统计学意义(P>0.05)。纳入标准:①长时间腰部疼痛,伴或不伴下肢运动、感觉异常或间歇性跛行;②动力位X射线显示滑脱节段位移≥3 mm或角度变化>10°,椎体向前滑移不超过椎体中部矢状径的1/4;③保守治疗6个月无效,且疼痛来源经选择性神经阻滞/椎间盘造影证实为滑脱节段;④随访资料完整。排除标准:①多个节段腰椎滑脱或Ⅱ、Ⅲ度及以上滑脱;②存在脊柱肿瘤、严重畸形、重度骨质疏松等;③T值≤-2.5且伴有脆性骨折史;④棘突源性疼痛(通过触诊/诊断性注射鉴别)及小关节源性疼痛(通过CT/MRI关节退变评估);⑤滑脱节段有手术史;⑥合并精神疾病。本研究经过我院伦理委员会的批准[批准号:(2024)伦审第(198)号]。

1.2 手术方法

所有手术均由同一组医师完成(主刀为具有10年以上脊柱内镜经验者),Endo-TLIF术者需完成超过50例内镜融合操作。

Endo-TLIF组:患者取俯卧位,X射线透视明确滑脱节段上下椎体的双侧椎弓根体表投影并做标记。分别于上下椎弓根标记点外缘作长约3 cm的竖切口,钝性分离皮下及肌肉组织,采用“隧道法”行椎弓根穿刺并置入导丝固定。沿同侧下位椎弓根切口置入工作通道,透视定位正确后置入内镜工作通道。利用电

凝刀头处理椎板上的软组织,使用可视环锯扩大同侧椎管显露黄韧带,髓核钳及椎板钳去除黄韧带等组织,显露神经根、硬膜囊和椎间盘。使用可视化铰刀和方形骨凿去除椎间盘和软骨终板组织,冲洗后置入自体骨和融合器。沿导丝拧入空心螺钉,双侧自尾端置入连接棒,顶丝固定。透视无误后,冲洗、缝合伤口,融合切口内放置负压引流管1根。术后24 h给予抗生素预防感染,术后1 d拔除引流管,指导患者下地。

MIS-TLIF组:患者取俯卧位,X射线透视确定滑脱节段并做体表标记。常规消毒、铺巾,取长6~8 cm的正中切口,两侧分离皮下及筋膜显露腰背部肌肉,钝性分离最长肌与多裂肌之间的间隙并逐步显露上关节突,沿椎弓根进针点植入定位针。冲洗、止血后固定自由臂,工作套筒固定至同侧上关节突,显微镜辅助下利用椎板钳扩大椎管,显露神经根和椎间盘组织。利用铰刀、刮刀去除椎间盘和软骨终板组织,冲洗后置入自体骨和融合器。取出定位针,拧入椎弓根螺钉,双侧自尾端置入连接棒,顶丝固定。透视无误后,冲洗和关闭伤口,融合侧伤口内放置负压引流管1根。术后24 h给予抗生素预防感染,术后2~3 d拔除引流管,并指导患者下地。

1.3 评价指标

记录患者手术相关指标,包括手术时间、术中透视次数、术中出血量、术后总引流量、术后住院时间等。于术前、术后3 d、术后3个月、术后6个月、术后1年,采用视觉模拟量表(visual analogue scale, VAS)评估患者的疼痛情况,采用Oswestry功能障碍指数(Oswestry disability index, ODI)评价患者日常生活能力。于术后1年随访时,通过腰椎正侧位X射线片评估2组患者滑脱复位、术后椎间隙高度、节段融合情况。滑脱复位:测量椎体滑移距离占上位椎体前后径的百分比,计算术后滑移程度较术前的改善比例;椎间隙高度:取责任节段椎间隙前缘、中点、后缘高度的平均值,反映术后椎间隙支撑效果;节段融合:采用改良Bridwell分级标准判定椎间骨性融合状态,Ⅰ~Ⅱ级为融合成功。统计2组患者术后并发症发生情况。

1.4 统计学分析

采用SPSS 20.0软件进行统计学分析,符合正态分布的计量数据以均数±标准差($\bar{x}\pm s$)表示,两组间比较选择独立样本t检验,多组间比较选择单因素方差分析;计数资料以率(%)表示,行χ^2检验。P<0.05为差异有统计学意义。

2 结果

2.1 2组患者手术相关指标比较

Endo-TLIF组患者的手术时间、术中透视次数均长/多于MIS-TLIF组(P<0.05),术中出血量、术后总引流量、术后住院时间均少/短于MIS-TLIF组(P<0.05),见表1。

2.2 2组患者手术前后VAS及ODI评分比较

2组患者术前及术后1年的VAS、ODI评分比较,差异无统计学意义(P>0.05);Endo-TLIF组患者术后3 d、术后3个月、术后6个月的VAS评分均低于MIS-TLIF组(P<0.05);Endo-TLIF组患者术后3 d、术后3个月ODI评分高于MIS-TLIF组,术后6个月ODI评分低于MIS-TLIF组(P<0.05),见表2、3。

表1 患者手术相关指标比较

组别	手术时间(h)	术中透视次数(次)	术中出血量(mL)	术后总引流量(mL)	术后住院时间(d)
Endo-TLIF组	3.44±0.77	19.18±3.89	25.29±11.79	131.76±33.54	3.82±0.73
MIS-TLIF组	2.08±0.53	9.00±0.82	200.00±129.10	258.08±31.46	5.00±2.12
t	5.732	10.481	5.580	10.496	2.138
P	0.000	0.000	0.000	0.000	0.041

表2 患者手术前后VAS评分比较($\bar{x}\pm s$,分)

组别	术前	术后3 d	术后3个月	术后6个月	术后1年	F	P
Endo-TLIF组	5.24±0.90	1.76±0.66	1.02±0.22	0.18±0.09	0.12±0.03	253.14	<0.001
MIS-TLIF组	5.31±0.95	2.92±0.76*	1.52±0.64*	0.77±0.14*	0.23±0.04	185.67	<0.001
F	$F_{组间}$=32.534,$F_{时间}$=82.425,$F_{交互}$=25.825						
P	$P_{组间}$<0.001,$P_{时间}$<0.001,$P_{交互}$<0.001						

*:与Endo-TLIF组相比,P<0.05

表3 患者手术前后ODI评分比较($\bar{x}\pm s$,分)

组别	术前	术后3 d	术后3个月	术后6个月	术后1年	F	P
Endo-TLIF组	55.08±3.97	43.69±3.45	33.81±4.26	6.31±4.23	1.62±0.16	874.652	<0.001
MIS-TLIF组	56.41±3.37	40.12±5.02*	29.57±2.53*	13.41±2.62*	1.59±0.14	1 232.644	<0.001
F	$F_{组间}$=52.673,$F_{时间}$=43.674,$F_{交互}$=34.915						
P	$P_{组间}$<0.001,$P_{时间}$<0.001,$P_{交互}$<0.001						

*:与Endo-TLIF组相比,P<0.05

2.3 2组患者影像学结果比较

2组患者滑脱复位率、术后椎间隙高度及节段融合率比较,差异均无统计学意义(P>0.05),见表4。

表4 患者影像学结果比较

组别	n	滑脱复位[例(%)]	术后椎间隙高度(mm)	节段融合[例(%)]
Endo-TLIF组	17	16(94.12)	9.62±1.23	16(94.12)
MIS-TLIF组	13	12(92.31)	9.45±1.31	12(92.31)
χ^2/t		0.038	0.364	0.038
P		0.843	0.718	0.843

2.4 2组患者并发症发生情况比较

2组患者均无切口感染、神经根损伤、脑脊液漏延迟愈合、血肿、内固定失败等严重并发症发生。Endo-TLIF组患者发生硬膜撕裂1例(5.88%),为术中微小撕裂,即刻缝合封闭,术后无脑脊液漏延迟愈合,未延长住院时间;MIS-TLIF组患者发生螺钉位置偏差1例(7.69%),术中透视发现并即时调整,未造成神经刺激或需二次手术。2组患者并发症总发生率比较,差异无统计学意义(P>0.05)。

3 讨论

近年来,脊柱融合技术逐步走向微创化,与传统开放手术相比,MIS-TLIF具有创伤小、恢复快等优点,深受临床医生与患者的青睐[12]。MIS-TLIF采用经椎间孔入路能够有效利用肌肉的天然间隙,减少了肌肉切除和剥离,同时对关节突关节和横突的有限暴露可进一步减少损伤,对椎管周围血运的不利影响更小,因此术中渗出的血液少、术后并发症发生率更低[13-14]。Endo-TLIF运用单通道实施关节突及椎板的切除,最大限度保留了脊柱后方的肌肉韧带复合体结构,以此维护脊柱的稳定性,进而减少术后腰部疼痛及僵硬症状的出现[15-16]。目前临床已证实上述两种术式在腰椎滑脱症的治疗中均具备良好的安全性与有效性,但目前针对Ⅰ度腰椎滑脱症,两种术式的近期疗效、影像学融合效果以及并发症发生情况的对比研究仍存在争议,不同研究的结论并不一致,临床对于两种术式的选择仍缺乏统一的共识。因此,本研究通过对比分析两种微创术式治疗Ⅰ度腰椎滑脱症的相关指标,明确两种术式的应用价值,为临床术式选择提供参考依据。

本研究对比了Endo-TLIF与MIS-TLIF治疗Ⅰ度腰椎滑脱症患者的临床效果,结果显示,Endo-TLIF组患者手术时间、术中透视次数均长/多于MIS-TLIF组,而术中出血量、术后总引流量、术后住院时间均少/短于MIS-TLIF组。这可能是由于Endo-TLIF为全程内镜下操作,对椎管减压、椎间处理、螺钉定位的精准度要求更高,步骤更精细,因此手术时间更长、透视定位次数更多;同时内镜下操作的视野局限,解剖结构辨认难度更大,也会在一定程度上延长操作时间。但全程内镜下操作对椎旁软组织的侵扰更小,能够更精准地切除病变组织,减少对周围正常组织的干扰,因此术中出血量和术后总引流量更少,患者术后恢复更快,进而缩短了住院时间。MIS-TLIF为通道辅助下的开放操作,虽然无需全程内镜下精细操作,手术步骤相对更快捷,透视次数更少,但对软组织的剥离范围略大于Endo-TLIF,因而术中出血量更多,患者术后恢复相对缓慢,住院时间也相应延长[17]。

术后影像学指标方面,Endo-TLIF组与MIS-TLIF组患者滑脱复位率、术后椎间隙高度、节段融合率无统计学差异,表明两种术式治疗Ⅰ度腰椎滑脱症均可获得满意疗效。Endo-TLIF组患者术后3 d及术后3个月、术后6个月的VAS评分均低于MIS-TLIF组。这是由于Endo-TLIF依托全程内镜直视操作,能更清晰地分辨神经、血管等正常组织,减少操作过程中对神经根的牵拉刺激与牵拉损伤,同时对椎旁肌肉等软组织的剥离和损伤更小,术后炎症反应更轻,因此术后早期的腰痛、下肢痛缓解更显著,功能改善更明显[18-19]。而MIS-TLIF尽管也属于微创术式,但仍需要建立工作通道操作,对软组织的侵扰程度高于Endo-TLIF,术后早期创伤反应更明显,因此疼痛评分更高,功能恢复相对较慢。本研究中Endo-TLIF组患者术后3 d、术后3个月ODI评分高于MIS-TLIF组,提示Endo-TLIF术后早期腰椎功能恢复略慢于MIS-TLIF。分析原因可能与内镜下操作对椎间孔周围结构的处理更精细、术后局部组织水肿消退周期略长有关,且内镜融合技术学习曲线相对陡峭,操作熟练度也可能对早期功能结局产生一定影响。本研究中术后6个月Endo-TLIF组患者ODI评分低于MIS-TLIF组,这是由于随着术后康复进程推进,局部水肿逐渐消退,内镜下更充分的神经减压和更稳定的椎间融合,使患者的腰椎功能持续改善,在远期功能恢复上优势更突出;至术后1年2组患者ODI评分无显著差异,提示两种术式的远期功能结局相当。本研究中2组患者并发症发生率无统计学差异,Ⅰ度腰椎滑脱症的核心治疗目标是充分减压神经根、实现椎间的稳定融合,同时尽可能减少手术对椎旁肌肉、后方韧带复合体的侵扰,避免术后腰背部僵硬疼痛的发生,而Endo-TLIF契合了这一微创治疗的发展理念。该术式全程在内镜直视下完成,可以清晰暴露神经根和硬膜囊,能够对受压结构进行精准清

除,在获得充分减压的同时,减少了对周围正常组织的侵扰,患者术后切口疼痛更轻,下床活动时间更早,更有利于早期康复,故而未延长患者的住院时间。内镜技术通过可视化操作实现精准减压,在Ⅰ度腰椎滑脱症的治疗中,并未因为操作视野的限制增加并发症风险,同时也说明Endo-TLIF在严格掌握手术适应证、规范操作的前提下,可以获得与MIS-TLIF相当的安全性。

综上所述,Endo-TLIF与MIS-TLIF治疗Ⅰ度腰椎滑脱症均可获得较好的临床效果,二者安全性相当,但Endo-TLIF对椎旁肌肉损伤更小,在减少术中出血、缩短住院时间、加快术后早期疼痛缓解与功能恢复方面更具优势,能更好地满足快速康复的要求。对于Ⅰ度腰椎滑脱症需要手术干预、且对术后康复速度有较高期待的患者,可优先选择Endo-TLIF。但本研究纳入样本量有限,且随访时间偏短,关于两种术式对远期融合率的影响,仍有待大样本、长期随访的研究进一步明确。

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