

· 临床研究 ·

微创经椎间孔入路腰椎椎间融合术治疗单节段腰椎退行性疾病对椎旁肌的影响

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【摘要】目的 对比微创经椎间孔入路腰椎椎间融合术(MIS-TLIF)与传统开放TLIF治疗单节段腰椎退行性疾病的临床疗效及椎旁肌损伤变化。**方法** 2017年1月—2020年1月收治单节段腰椎退行性疾病患者41例, 其中18例采用MIS-TLIF治疗(MIS-TLIF组), 23例采用TLIF治疗(对照组)。记录2组患者卧床时间、住院时间, 术前和术后1、3、5 d血清肌酸激酶(CK)、白介素-6(IL-6)水平; 术前及术后6、12个月采用疼痛视觉模拟量表(VAS)评分和Oswestry功能障碍指数(ODI)评估患者腰腿痛程度和腰椎功能状况。在术前、术后12个月MRI上测量手术节段及邻近节段多裂肌横截面积(MCSA), 并计算其变化率。**结果** 所有手术顺利完成, 患者随访(12.40 ± 0.35)个月。MIS-TLIF组术后卧床时间、住院时间均短于对照组, 差异有统计学意义($P < 0.05$)。2组CK、IL-6血清浓度在术后呈显著升高趋势, 其峰值均出现在术后1 d, 术后3、5 d逐渐下降; MIS-TLIF组术后1 d的CK、IL-6血清浓度显著低于对照组, 差异有统计学意义($P < 0.05$)。2组术后6、12个月的VAS评分、ODI较术前显著改善, MIS-TLIF组术后6个月的ODI较对照组更低, 差异均有统计学意义($P < 0.05$)。2组中各10例患者末次随访时复查腰椎MRI, MIS-TLIF组术后12个月责任节段MCSA显著大于对照组, MCSA减少率显著低于对照组, 差异均有统计学意义($P < 0.05$)。而MIS-TLIF组术后12个月邻近节段MCSA与对照组相比, 差异无统计学意义($P > 0.05$); 但邻近节段MCSA减少率显著低于对照组, 差异有统计学意义($P < 0.05$)。**结论** MIS-TLIF较传统开放手术具有切口小、组织损伤少、功能康复快等特点, 且在术后早期患者全身炎性反应更轻, 术后中期对多裂肌的干扰更小。

【关键词】 腰椎; 椎间盘退行性变; 肌萎缩; 脊柱融合术; 外科手术, 微创性

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Effect of minimally invasive transforaminal lumbar interbody fusion on paravertebral muscles in treatment of single level lumbar degenerative diseases

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【Abstract】 Objective To compare the clinical efficacy and changes of paraspinal muscle injury of minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) and traditional TLIF in the treatment of single level lumbar degenerative diseases. **Methods** From January 2017 to January 2020, 41 patients with single level lumbar degenerative diseases were treated, of which 18 patients were treated with MIS-TLIF (MIS-TLIF group) and 23 patients with TLIF (control group). The bed rest time and hospital stay were recorded; the changes of serum creatine kinase (CK) and interleukin-6 (IL-6) levels before operation and at 1, 3, and 5 d after operation were analyzed. The visual analogue scale (VAS) score and Oswestry disability index (ODI) were used to evaluate low back and leg pain and lumbar function before operation and at 6, 12 months after operation. The multifidus cross-sectional area (MCSA) of the operated and adjacent segments were measured on MRIs before and 12 months after operation, and the change rate was calculated. **Results** All the operations were completed successfully, and the patients were follow-up for (12.40 ± 0.35) months. The postoperative bed rest time and hospital stay in MIS-TLIF group were shorter than those in the control group, and the differences were statistically significant ($P < 0.05$). The serum concentrations of CK and IL-6 in the 2 groups showed a significantly increased trend after operation, and their peaks appeared at postoperative 1 d and gradually decreased at postoperative 3 and 5 d. The serum levels of CK and IL-6 in

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MIS-TLIF group were significantly lower than those in the control group at postoperative 1 d, and the differences were statistically significant ($P < 0.05$). The VAS score and ODI of the 2 groups at postoperative 6 and 12 months were significantly improved compared with those before operation, and ODI of MIS-TLIF group at postoperative 6 months was lower than that of the control group, all with a statistically significant difference ($P < 0.05$). Lumbar MRI of 10 patients in each group was reviewed at the final follow-up; and MCSA at operated segment in MIS-TLIF group was significantly higher than that in the control group, and the MCSA change rate at operated segment was significantly lower than that in the control group, all with a statistical difference ($P < 0.05$). There was no significant difference in MCSA at adjacent segments between the 2 groups at the final follow-up ($P > 0.05$), however, the MCSA change rate at adjacent segments in MIS-TLIF group was significantly lower than that in the control group, and the difference was statistically significant ($P < 0.05$). **Conclusion** Compared with traditional open TLIF, MIS-TLIF has the characteristics of smaller incision, less tissue damage, faster functional recovery, and lighter systemic inflammatory response in the early postoperative period, and less interference to the multifidus muscle in the middle postoperative period.

【Key Words】 Lumbar vertebrae; Intervertebral disc degeneration; Muscular atrophy; Spine fusion; Surgical procedures, minimally invasive

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经椎间孔入路腰椎椎间融合术(TLIF)由Harms等^[1]于1982年首次报道。相较于后路腰椎椎间融合术(PLIF), TLIF极大减少了术中对椎管内硬膜囊的牵拉及神经根损伤的发生;但开放手术切口较大,术中广泛的软组织剥离、牵拉均会严重影响椎旁肌,导致其变性、坏死^[2-3]。2003年,Foley等^[4]报道了采用微创经椎间孔入路腰椎椎间融合术(MIS-TLIF)治疗腰椎退行性疾病,旨在保留与TLIF相当的手术疗效的前提下,实现最小的手术相关损伤。有研究显示,MIS-TLIF较TLIF具有出血量少^[5-6],术后肌肉水肿、萎缩面积小^[7],腰背痛发生率低^[8]等优点。相关的血清肌酶及细胞因子浓度研究^[8]也证明MIS-TLIF更符合微创手术理念。传统腰椎手术采用沿椎板剥离肌肉的方法,导致离椎板最近的多裂肌受到直接影响^[9-10]。因此,本研究通过对MIS-TLIF和TLIF治疗单节段腰椎退行性疾病手术前后的多裂肌损伤程度、炎性因子、临床指标等变化情况,探讨2种术式对椎旁肌损伤影响的差异性及其

临床意义,现报告如下。

1 资料与方法

1.1 一般资料

纳入标准:①以严重腰腿痛或间歇性跛行为主要临床症状;②影像学检查结果提示单节段腰椎椎间盘突出、腰椎椎管狭窄或腰椎滑脱不稳(I度滑脱),且与症状、体征一致;③经严格非手术治疗3个月及以上无效。排除标准:①既往腰椎肿瘤、畸形、感染、骨折等病史;②手术邻近节段严重退行性变;③既往手术史;④伴有全身感染性疾病、自身免疫系统疾病或其他严重基础疾病。按照上述标准,2017年1月—2020年1月收治单节段腰椎退行性疾病患者41例,其中18例采用MIS-TLIF治疗(MIS-TLIF组),23例采用TLIF治疗(对照组)。2组患者术前一般资料差异无统计学意义($P > 0.05$,表1),具有可比性。2组手术均由同一组医师完成。

表1 2组患者一般资料

Tab. 1 General data of 2 groups

组别 Group	n	性别 Gender		年龄/岁 Age/year	体质量指数/ (kg·m ⁻²) Body mass index/(kg·m ⁻²)	吸烟史 Smoking history	疾病类型 Disease type		手术节段 Operated segment			
		男 Male	女 Female				腰椎椎间盘 突出症 Lumbar disc herniation	腰椎椎管 狭窄症 Lumbar spinal stenosis	腰椎滑脱症 Lumbar spondylolisthesis	L ₃ /L ₄	L ₄ /L ₅	L ₅ /S ₁
MIS-TLIF	18	9	9	49.63 ± 16.22	26.11 ± 3.52	3	6	7	5	1	9	8
对照 Control	23	12	11	50.00 ± 10.69	25.37 ± 4.15	4	8	10	5	1	14	8

1.2 手术方式

MIS-TLIF组患者全身麻醉后取俯卧位, 透视确定病变节段并作标记。于减压侧正中旁开3 cm做1个多裂肌外侧切口, 安装Spotlight通道及光源(强生, 美国), 显露减压节段椎板、关节突, 切除下关节突及部分椎板, 直视下显露上关节突及黄韧带并部分切除, 游离并牵开硬膜囊和神经根, 切开纤维环, 掏出髓核组织, 刮匙处理终板软骨, 将剪碎的自体骨粒植入椎间隙, 取合适的OIC融合器(史赛克, 美国)装入自体骨碎骨粒后置入椎间隙。取出工作通道, 在同侧将穿刺针置于上、下小关节横突根部与上关节突交界处, 在对侧透视后于椎弓根外缘投影位置偏外1~2 cm处做2个1 cm纵向切口, 打开筋膜, 透视确定进针位置后适度内聚置入穿刺针, 正侧位X线透视确认针尖安全进入椎体后, 插入导引钢丝, 攻丝后拧入4枚椎弓根螺钉(Depuy Viper; 强生, 美国), 安装合适长度的预弯固定棒, 螺钉间纵向加压后拧紧螺帽。

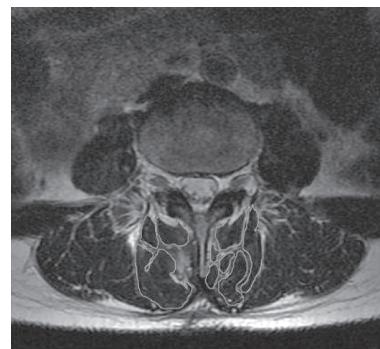
对照组患者全身麻醉后取俯卧位, 采用后正中入路, 剥离椎旁肌肉, 显露手术节段椎板及关节突, 先拧入4枚椎弓根螺钉(Depuy Expedium; 强生, 美国), 切除病变节段上下部分椎板及一侧小关节突, 显露硬膜囊及神经根, 牵开并保护神经, 切除椎间盘, 刮匙处理上、下终板软骨, 将剪碎的自体骨植入椎间隙, 取合适的OIC融合器(史赛克, 美国)装入自体骨碎骨粒后置入椎间隙, 安装固定棒, 螺钉间纵向加压后拧紧螺帽。手术部位放置引流管。

1.3 观察指标

记录2组患者卧床时间及住院时间。术前和术后1、3、5 d进行血清学检查, 评价肌酸激酶(CK)、白介素-6(IL-6)在各时间点的血清浓度变化情况。于术前、术后6个月、术后12个月采用疼痛视觉模拟量表(VAS)评分^[11]和Oswestry功能障碍指数(ODI)^[12]评估腰腿痛程度和腰椎功能状况。

根据以往解剖学研究^[13], 多裂肌与外侧最长肌被充满脂肪和静脉的宽裂隙隔开, 形成明显的肌间隙。患者于术前及术后12个月行腰椎X线、MRI检查, 采用医学影像存档与传输系统(PACS)对多裂肌横断面中单纯肌肉部分的面积进行测定, 并将该测定值作为多裂肌横截面积(MCSA)^[14], 根据MRI T2加权像上的信号强度区分肌肉、骨、脂肪和其他软组织, 以此计算双侧MCSA总和(图1)。测定节段包括手术节段及其上位邻近节段, 为保证测量准确性, 手术前后均测定节段MRI首层MCSA, 以

避免术后螺钉所致过多伪影使测定结果产生误差。MCSA变化率(%)=(术前MCSA-术后MCSA)/术前MCSA×100%。由1名骨科专业医师对影像学资料进行阅片、MCSA测定及MCSA变化率计算。



注: 白线描绘面积总和即 MCSA。

Note: MCSA is sum of areas depicted by white lines.

图1 MCSA 测定范围

Fig. 1 Scope of MCSA measurement

1.4 统计学处理

采用SPSS 9.0软件对数据进行统计分析, 符合正态分布的计量资料以 $\bar{x} \pm s$ 表示, 率的比较采用 χ^2 检验, 组间VAS评分、ODI、MCSA比较采用t检验, 不同时间点CK、IL-6比较采用可重复测量方差分析。以 $P < 0.05$ 为差异有统计学意义。

2 结 果

所有手术顺利完成, 患者随访(12.40 ± 0.35)个月。MIS-TLIF组患者术后不放置引流管; 对照组引流管放置时间为(4.2 ± 1.2)d, 引流量为(304.3 ± 57.5)mL。MIS-TLIF组术后卧床时间、住院时间均短于对照组, 差异有统计学意义($P < 0.05$, 表2)。2组患者CK、IL-6血清浓度在术后呈显著升高趋势, 其峰值均出现在术后1 d, 术后3、5 d逐渐下降; MIS-TLIF组术后1 d的CK、IL-6血清浓度显著低于对照组, 差异有统计学意义($P < 0.05$, 表2)。2组术后6、12个月的VAS评分、ODI较术前显著改善, MIS-TLIF组术后6个月的ODI较对照组更低, 差异均有统计学意义($P < 0.05$, 表2)。

2组中各有10例患者在末次随访时复查腰椎MRI。MIS-TLIF组术后12个月责任节段MCSA显著大于对照组, MCSA变化率显著低于对照组, 差异均有统计学意义($P < 0.05$, 表3)。而MIS-TLIF组术后12个月邻近节段MCSA与对照组相比, 差异无统计学意义($P > 0.05$, 表3); 但邻近节段MCSA变化率显著低于对照组, 差异有统计学意义($P < 0.05$, 表3)。

表2 2组临床疗效指标
Tab. 2 Clinical efficacy indexes of 2 groups

组别 Group	n	卧床时间/d Bed rest time/d	住院时间/d Hospital stay/d	CK/(U·L ⁻¹)			
				术前 Pre-operation	术后1 d Postoperative 1 d	术后3 d Postoperative 3 d	术后5 d Postoperative 5 d
MIS-TLIF	18	1.2 ± 0.3 [*]	3.2 ± 1.4 [*]	95.93 ± 69.94	425.18 ± 278.92 [*]	331.43 ± 233.78	128.50 ± 108.46
对照 Control	23	5.3 ± 1.5	6.1 ± 2.5	93.76 ± 81.68	802.95 ± 646.38	347.33 ± 303.19	142.38 ± 115.28
IL-6/(pg·mL ⁻¹)							
组别 Group		术前 Pre-operation	术后1 d Postoperative 1 d	术后3 d Postoperative 3 d	术后5 d Postoperative 5 d		
MIS-TLIF		2.30 ± 1.28	25.74 ± 18.79 [*]	16.50 ± 12.66	9.93 ± 5.89		
对照 Control		2.98 ± 1.88	90.38 ± 66.08	25.04 ± 17.60	10.78 ± 8.46		
VAS评分 VAS score							
组别 Group		术前 Pre-operation	术后6个月 Postoperative 6 months	术后12个月 Postoperative 12 months	术前 Pre-operation	术后6个月 Postoperative 6 months	术后12个月 Postoperative 12 months
MIS-TLIF		6.37 ± 1.85	1.50 ± 1.26	1.30 ± 1.13	46.45 ± 21.78	11.06 ± 9.19 [*]	7.46 ± 5.92
对照 Control		6.23 ± 1.86	1.90 ± 1.33	1.30 ± 1.75	41.76 ± 16.21	17.61 ± 9.96	8.48 ± 5.47

注: *与对照组相比, $P < 0.05$ 。

Note: * $P < 0.05$, compared with control group.

表3 2组获得MRI随访患者手术前后MCSA变化

Tab. 3 MCSA changes before and after operation in 2 groups of patients with MRI follow-up

组别 Group	n	责任节段 MCSA MCSA of operated level			邻近节段 MCSA MCSA of adjacent level		
		术前/cm ² Pre-operation/ cm ²	术后12个月/cm ² Postoperative 12 months/ cm ²	变化率(%) Change rate(%)	术前/cm ² Pre-operation/ cm ²	术后12个月/cm ² Postoperative 12 months/ cm ²	变化率(%) Change rate(%)
MIS-TLIF	10	12.800 ± 1.898	11.342 ± 1.799 [*]	11.48 ± 3.66 [*]	12.811 ± 1.789	11.856 ± 1.331	7.10 ± 4.55 [*]
对照 Control	10	13.239 ± 1.994	9.727 ± 1.520	26.53 ± 3.43	12.853 ± 1.557	10.258 ± 2.183	20.87 ± 9.29

注: *与对照组相比, $P < 0.05$ 。

Note: * $P < 0.05$, compared with control group.

3 讨 论

有研究^[9]报道, 腰椎开放手术需要将双侧多裂肌及其他椎旁肌从棘突、椎板和关节突关节向两侧剥离, 并长时间使用拉钩对多裂肌进行牵拉, 以及术中应用电刀止血等操作均会造成多裂肌损伤, 导致其缺血、纤维化、脂肪化, 甚至坏死, 使多裂肌发生远期病变, 影响其功能。已有研究^[2, 15-17]证实, 腰椎开放手术中拉钩造成的肌肉损伤程度与拉钩对

肌肉施加的压力、牵拉时间等因素直接相关。亦有动物研究^[18-19]显示, 对兔子模型单纯的肌肉撑开或肌肉与骨骼组织分离, 即可以造成多裂肌损伤, 损伤程度与多裂肌撑开时间相关。而MIS-TLIF自临床应用以来, 多项研究证实其可减少医源性损伤。Peng等^[20]的研究显示, MIS-TLIF在术中出血量、术后镇痛药物用量、住院时间、卧床时间、并发症等方面较开放手术更具优势。Shunwu等^[21]和Ge等^[22]的研究发现, MIS-TLIF与开放手术疗效相当, 且具

有术中出血量少、术后康复时间短、残留腰背痛少、住院率低等优势。本研究结论与上述研究结论相似, MIS-TLIF组术后卧床时间、住院时间及ODI均显著低于对照组, 患者术后疗效更好, 对肌肉干扰更少, 而2组患者术后VAS评分差异无统计学意义, 说明患者术后疼痛普遍得到缓解。

腰椎开放手术不可避免地会大面积剥离、撑开椎旁肌并造成其损伤、功能下降, 肌肉组织受损在病理学上表现为萎缩、水肿、脂肪浸润, MRI等影像学检查显示为肌肉横截面积和体积减少^[23-25]。梁瑞歌等^[26]的研究发现, 退行性腰椎侧凸患者椎旁肌横截面积减少的同时脂肪化程度更明显。Mattila等^[27]对腰椎翻修手术的患者进行术中多裂肌活检发现, 肌肉有不同程度纤维化和萎缩。虽然大范围开展上述方式的取材进行研究有一定困难, 但可据此推测, 多裂肌纤维化和萎缩的情况在腰椎术后患者中普遍存在^[28]。同时, 椎旁肌在维持脊柱稳定性中有着重要作用。Choi等^[29]的研究发现, PLIF术中单纯应用椎间融合器患者的融合率与术前椎旁肌横截面积相关。崔晓伟^[30]的研究发现, 多裂肌退行性变可能参与了退行性腰椎滑脱的进程。微创手术能够有效保护椎旁肌, 避免肌肉损伤后的一系列后果。Lv等^[31]的研究发现, MIS-TLIF相对开放手术能够有效降低椎旁肌在手术撑开期间及解除撑开后的压力, 并可减少术后3年内椎旁肌的萎缩。Kim等^[32]的研究显示, 微创组患者在腰部后伸运动时活动度改善>50%, 而开放组无明显改善, 后伸强度和多裂肌残留横截面积呈正相关。Hyun等^[33]对接受TLIF单侧内固定和对侧Wiltse入路行MIS-TLIF治疗的2组患者资料进行对比分析, 结果显示, MIS-TLIF组术后MCSA减少显著低于TLIF组。Fan等^[34]的研究也发现, 无论在手术节段还是邻近节段, MIS-TLIF对MCSA以及MRI T2加权像灰度值的影响均小于开放PLIF。Fu等^[35]的研究显示, 术后1年开放组患者较MIS-TLIF组患者竖脊肌脂肪浸润更明显。Zhu等^[36]的研究表明, 经椎旁肌间隙入路的PLIF能够有效保护椎旁肌, 从而更好地保持腰椎生理曲度, 减少疼痛, 患者满意度更佳, 且难治性腰痛及邻椎病更多地出现在术后多裂肌萎缩的患者中。本研究结果显示, MIS-TLIF组无论责任节段还是邻近节段, MCSA变化率均显著优于对照组。由于正常MCSA从上位腰椎旁开始向下逐渐递增, 故不同节段层面MCSA差异较大, MCSA绝对值容易出现统计误差。本研究采用MCSA变化率更能反映手术方

式对不同节段多裂肌的影响。有研究^[34]报道, 灰度值可作为反映多裂肌病变程度的衡量指标, 但本研究并未采用该指标, 主要考虑椎弓根螺钉的伪影不可避免地会影响灰度值的可靠性。Dhall等^[37]的研究证实, 术后10~12个月多裂肌存在不同程度水肿会对测量灰度值的准确性产生干扰。

MIS-TLIF的微创性不仅体现在手术区域局部, 也在全身血液循环中某些血清酶和细胞因子浓度变化中有所体现。其中, 临幊上最常用的肌肉损伤评价指标为血清CK水平, 其半衰期相对较长(20~24 h), 可用来评价术后早期肌肉损伤情况。IL-6作为一种细胞炎性因子, 也是一种重要的肌肉损伤评价指标^[38]。Kim等^[8]对比了微创和开放手术前后CK水平的变化情况, 发现2组患者的CK水平均在术后1 d达到峰值, 其后逐渐下降, 在术后7 d回归基线; 且术后1、3 d, 微创组CK水平显著低于开放组, 同样的情况也在IL-6的血清浓度中得到体现。Fan等^[34]的研究表明, 微创组术后1、3、5 d的CK水平显著低于开放组。本研究结果显示, 对照组在术后3 d的血清CK水平和IL-6就回归到较低浓度水平, 和MIS-TLIF组相当。其原因可能为, 对照组患者的手术同样趋向于低侵袭原则, 在术前均进行了精确的X线定位, 避免了切口的偏差及不必要的软组织损伤, 而术者在术中也尽可能保护椎旁肌, 使组织损伤降到最低。

大量国内外研究^[8, 34, 39]对开放与微创手术造成的椎旁肌损伤进行了比较, 但多为PLIF与微创手术的比较。相对于传统PLIF, 损伤更小的TLIF与MIS-TLIF的对比更能说明微创手术的优势。目前, 关于更为精确的肌肉面积变化率及中长期影响方面的研究仍然缺乏, 本研究通过比较术后早期血清学相关指标, 中期随访中的MCSA变化率, 为MIS-TLIF较传统开放手术后早中期对椎旁肌的影响更小这一结论提供了新的证据。

本研究存在样本量小、随访时间短等局限性; 同时, 术后12个月的MRI可能存在水肿信号, 在一定程度上干扰了MCSA的测算。且本研究术后只采集了1次MRI影像, 如能增加术后6、9、24个月等的MRI影像资料, 则更能反映椎旁肌肉损伤的变化情况, 并增加T2加权像横断面抑脂相研究, 也可让结果更有说服力。

综上, MIS-TLIF较开放TLIF具有切口小、组织损伤少、功能康复快等优点, 且在术后早期患者全身炎性反应更轻, 术后中期对多裂肌的干扰更小。

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