

## · 临床研究 ·

经皮内窥镜下腰椎间盘突出术中椎间孔成形的  
适应证研究

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**摘要 目的:**探讨经皮内窥镜下腰椎间盘突出术中椎间孔成形的适应证。**方法:**选取经椎间孔入路行经皮内窥镜下腰椎间盘突出术的单节段腰椎间盘突出症患者, 其中 36 例患者术中进行了椎间孔成形(椎间孔成形组), 50 例患者术中未进行椎间孔成形(椎间孔未成形组)。在患者术前的 CT 图像上测定病变节段的椎间隙高度、椎间孔宽度、椎板角, 在术前 X 线片上测定患者的髂嵴高度, 在术前 MRI 上测定突出椎间盘的下移程度。**结果:**椎间孔成形组椎间隙高度低于椎间孔未成形组[(5.92 ± 1.22) mm, (6.74 ± 0.92) mm,  $t = -3.555$ ,  $P = 0.004$ ], 突出椎间盘向下重度移位者所占比例高于椎间孔未成形组( $P = 0.031$ ); 2 组患者的椎间孔宽度、椎板角及髂嵴高度比较, 组间差异均无统计学意义[(6.92 ± 1.03) mm, (7.07 ± 1.20) mm,  $t = -0.606$ ,  $P = 0.566$ ; 99.52° ± 10.62°, 98.23° ± 8.77°,  $t = 0.616$ ,  $P = 0.739$ ; (33.38 ± 1.06) mm, (32.69 ± 2.24) mm,  $t = 1.713$ ,  $P = 0.164$ ]。L<sub>5</sub>S<sub>1</sub> 腰椎间盘突出症患者中, 椎间孔成形组的椎间隙高度、椎间孔宽度均小于椎间孔未成形组[(4.13 ± 1.22) mm, (5.19 ± 0.92) mm,  $t = -3.198$ ,  $P = 0.006$ ; (5.89 ± 1.38) mm, (7.28 ± 1.28) mm,  $t = -3.387$ ,  $P = 0.002$ ], 髂嵴高度大于椎间孔未成形组[(35.26 ± 3.44) mm, (32.78 ± 2.86) mm,  $t = 2.549$ ,  $P = 0.001$ ]; 2 组患者的椎板角、突出椎间盘下移程度比较, 组间差异均无统计学意义(96.52° ± 8.62°, 95.23° ± 6.77°,  $t = 0.542$ ,  $P = 0.173$ ;  $P = 0.476$ )。中央型腰椎间盘突出症患者中, 椎间孔成形组的椎间隙高度小于椎间孔未成形组[(5.66 ± 0.75) mm, (6.93 ± 0.92) mm,  $t = -3.499$ ,  $P = 0.006$ ], 椎板角大于椎间孔未成形组(103.58° ± 5.32°, 92.38° ± 4.37°,  $t = 5.426$ ,  $P = 0.001$ ); 2 组患者的椎间孔宽度、髂嵴高度、突出椎间盘下移程度比较, 组间差异均无统计学意义[(5.86 ± 1.46) mm, (7.18 ± 1.41) mm,  $t = -2.152$ ,  $P = 0.472$ ; (33.25 ± 2.01) mm, (34.03 ± 1.63) mm,  $t = 0.289$ ,  $P = 0.775$ ;  $P = 0.455$ ]。**结论:**病变节段椎间隙狭窄的腰椎间盘突出症、突出物向下移位严重的腰椎间盘突出症、髂嵴较高的 L<sub>5</sub>S<sub>1</sub> 椎间盘突出症、病变节段椎板角较大的中央型腰椎间盘突出症, 均应视为经皮内窥镜下腰椎间盘突出术中椎间孔成形的适应证。

**关键词** 椎间盘移位; 腰椎; 内窥镜检查; 椎间孔; 适应证

**A clinical study of indications of foraminoplasty in percutaneous endoscopic lumbar discectomy**

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**ABSTRACT Objective:** To explore the indications of foraminoplasty in percutaneous endoscopic lumbar discectomy (PELD). **Methods:** Eighty-six patients with single-segment lumbar disc herniation (LDH) who received PELD through intervertebral foramina approach were selected. The foraminoplasty was performed on 36 patients (foraminoplasty group) and was not performed on 50 patients (non-foraminoplasty group) during the PELD. The intervertebral space height, the intervertebral foramina width and the vertebral plate angle of diseased segment were measured on patients' preoperative CT images. The iliac crest height and the downward-displacement degree of herniated intervertebral disc were measured on patients' preoperative CT images and preoperative MRI respectively. **Results:** The intervertebral space heights were lower, and the proportion of patients with severe downward-displacement of herniated intervertebral discs was higher in foraminoplasty group compared to non-foraminoplasty group (5.92 ± 1.22 vs 6.74 ± 0.92 mm,  $t = -3.555$ ,  $P = 0.004$ ;  $P = 0.031$ ). There was no statistical difference in intervertebral foramina width, vertebral plate angle and iliac crest height between foraminoplasty group and non-foraminoplasty group (6.92 ± 1.03 vs 7.07 ± 1.20 mm,  $t = -0.606$ ,  $P = 0.566$ ; 99.52 ± 10.62 vs 98.23 ± 8.77 degrees,  $t = 0.616$ ,  $P = 0.739$ ; 33.38 ± 1.06 vs 32.69 ± 2.24 mm,  $t = 1.713$ ,  $P = 0.164$ ). For patients with L<sub>5</sub>-S<sub>1</sub> LDH, the intervertebral space heights and the intervertebral foramina widths were smaller and the iliac crest heights were greater in foraminoplasty group compared to non-foraminoplasty group (4.13 ± 1.22 vs 5.19 ± 0.92 mm,  $t = -3.198$ ,  $P = 0.006$ ; 5.89 ± 1.38 vs 7.28 ± 1.28 mm,

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$t = -3.387, P = 0.002; 35.26 \pm 3.44$  vs  $32.78 \pm 2.86$  mm,  $t = 2.549, P = 0.001$ ), while there was no statistical difference in vertebral plate angle and downward displacement degree of herniated intervertebral discs between foraminoplasty group and non-foraminoplasty group ( $96.52 \pm 8.62$  vs  $95.23 \pm 6.77$  degrees,  $t = 0.542, P = 0.173; P = 0.476$ ). For patients with central-type LDH, the intervertebral space heights were smaller and the vertebral plate angles were larger in foraminoplasty group compared to non-foraminoplasty group ( $5.66 \pm 0.75$  vs  $6.93 \pm 0.92$  mm,  $t = -3.499, P = 0.006; 103.58 \pm 5.32$  vs  $92.38 \pm 4.37$  degrees,  $t = 5.426, P = 0.001$ ), while there was no statistical difference in intervertebral foramina width, iliac crest height and downward displacement degree of herniated intervertebral discs between foraminoplasty group and non-foraminoplasty group ( $5.86 \pm 1.46$  vs  $7.18 \pm 1.41$  mm,  $t = -2.152, P = 0.472; 33.25 \pm 2.01$  vs  $34.03 \pm 1.63$  mm,  $t = 0.289, P = 0.775; P = 0.455$ ). **Conclusion:** LDH with narrow intervertebral space at diseased segment, LDH with severe downward displacement of herniated disc, L<sub>5</sub>-S<sub>1</sub> LDH with high iliac crest and central-type LDH with large vertebral plate angle at diseased segment should be regarded as the indications of foraminoplasty in PELD.

**Keywords** intervertebral disc displacement; lumbar vertebrae; endoscopy; intervertebral foramina; indicatio

随着手术技巧及手术器械的不断改进,经皮内窥镜下腰椎间盘突出术的适应证越来越广泛<sup>[1]</sup>。对于某些特殊类型的腰椎间盘突出症,由于腰椎正常解剖结构或退变的组织结构阻挡,术中无法在理想的位置建立工作通道,不能进行有效减压,影响手术效果<sup>[2]</sup>。对于此类患者,术中需要进行椎间孔成形,以解决工作通道建立的问题。目前尚无针对椎间孔成形术适应证的量化研究。为此,我们通过回顾性研究,从影像学角度探讨了经皮内窥镜下腰椎间盘突出术中椎间孔成形的适应证,现总结报告如下。

## 1 临床资料

纳入研究的患者共 86 例,均为 2015 年 7 月至 2016 年 7 月在苏州市中医医院住院治疗的腰椎间盘突出症患者,均经腰椎 X 线、CT 及 MRI 检查确诊为单节段椎间盘突出,均经 6 周以上非手术治疗效果欠佳。均经椎间孔入路行经皮内窥镜下腰椎间盘突出术,其中 36 例患者术中进行了椎间孔成形(椎间孔成形组),其余 50 例患者术中未进行椎间孔成形(椎间孔未成形组)。2 组患者的基线资料比较,差异无统计学意义,有可比性(表 1)。试验方案经医院医学伦理委员会审查通过。

## 2 方 法

### 2.1 影像学测量 在患者术前的 CT 图像上测定病

变节段的椎间隙高度、椎间孔宽度、椎板角,在术前 X 线片上测定患者的髂嵴高度,在 MRI 上测定突出椎间盘的下移程度。

在 CT 矢状位椎弓根中线层面图像上,病变节段椎间隙上位椎体下终板后缘与下位椎体上终板后缘连线的长度即为椎间隙高度(图 1);病变节段椎间隙下位椎体上关节突中点至上位椎体下终板后缘与下位椎体上终板后缘连线的垂直距离即为椎间孔宽度(图 2)。在冠状位 CT 图像上,两侧椎板间的夹角即为椎板角(图 3)。在脊柱正位 X 线片上,两侧髂嵴最高点连线至 S<sub>1</sub> 上终板的垂直距离即为髂嵴高度(图 4)。在矢状位 MRI 上采用以下标准评定突出椎间盘的下移程度:分别经病变节段椎间隙下位椎体上方后缘和椎弓根下切迹作水平线,并在两线之间作中线;突出椎间盘组织高于中线为轻度下移或无下移,低于中线为重度下移<sup>[3]</sup>(图 5)。

**2.2 数据统计** 采用 SPSS19.0 软件进行数据分析。2 组患者性别、椎间盘突出类型的组间比较均采用  $\chi^2$  检验,椎间盘突出节段、突出椎间盘下移程度的组间比较均采用 Fisher 确切概率法,年龄、椎间隙高度、椎间孔宽度、椎板角、髂嵴高度的组间比较均采用  $t$  检验。检验水准  $\alpha = 0.05$ 。

表 1 2 组腰椎间盘突出症患者基线资料比较

组别	样本量 (例)	性别(例)		年龄 ( $\bar{x} \pm s$ , 岁)	椎间盘突出节段(例)				椎间盘突出类型(例)	
		男	女		L <sub>2-3</sub>	L <sub>3-4</sub>	L <sub>4-5</sub>	L <sub>5</sub> S <sub>1</sub>	中央型	旁中央型
椎间孔成形组	36	27	9	42.8 ± 12.5	1	1	14	20	10	26
椎间孔未成形组	50	32	18	45.3 ± 8.9	1	3	24	22	12	38
检验统计量		$\chi^2 = 1.176$		$t = -1.084$					$\chi^2 = 0.157$	
P 值		0.278		0.861	0.684				0.692	



图 1 椎间隙高度测定方法



图 2 椎间孔宽度测定方法



图 3 椎板角测定方法

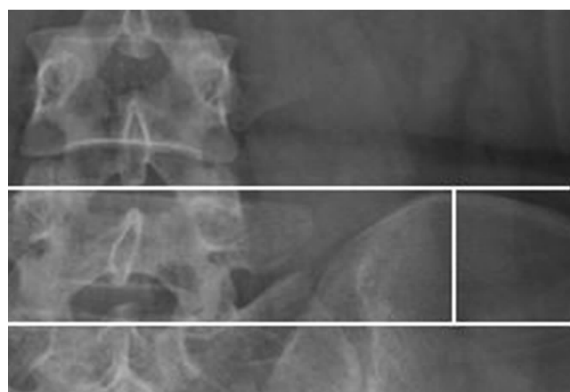


图 4 髂嵴高度测定方法

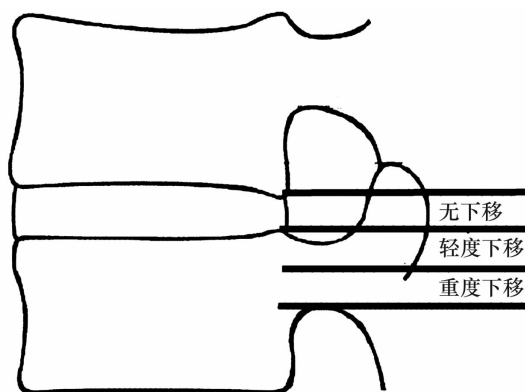


图 5 突出椎间盘下移程度的评定方法

### 3 结果

椎间孔成形组椎间隙高度低于椎间孔未成形组,突出椎间盘向下重度移位者所占比例高于椎间孔未成形组;2 组患者的椎间孔宽度、椎板角及髂嵴高度比较,组间差异均无统计学意义(表 2)。L<sub>5</sub>S<sub>1</sub> 腰椎间盘突出症患者中,椎间孔成形组的椎间隙高度、椎间孔宽度均小于椎间孔未成形组,髂嵴高度大于椎间孔未成形组;2 组患者的椎板角、突出椎间盘下移程度比较,组间差异均无统计学意义(表 3)。中央型腰椎间盘突出症患者中,椎间孔成形组的椎间隙高度小于椎间孔未成形组,椎板角大于椎间孔未成形组;2 组患者的椎间孔宽度、髂嵴高度、突出椎间盘下移程度比较,组间差异均无统计学意义(表 4)。

### 4 讨论

经皮椎间孔成形术最初是由 Knight 等<sup>[4]</sup>提出的,该技术极大地扩展了经皮内窥镜下腰椎间盘突出切除术的适应证<sup>[5]</sup>。对于向下移位较为严重的椎间盘突出,既往常需行开放手术。进行经皮椎间孔成形后,可获得下位椎体后方的视野,镜下直接对突出髓核进行摘除减压。由于存在椎间孔小、椎间隙窄、椎间孔容易被髂嵴阻挡等因素<sup>[6]</sup>,L<sub>5</sub>S<sub>1</sub> 节段经椎间孔入路建立通

表 2 2 组腰椎间盘突出症患者影像学指标比较

组别	样本量 (例)	椎间隙高度 ( $\bar{x} \pm s$ , mm)	椎间孔宽度 ( $\bar{x} \pm s$ , mm)	椎板角 ( $\bar{x} \pm s$ , °)	髂嵴高度 ( $\bar{x} \pm s$ , mm)	突出椎间盘下移程度(例)	
						轻度或无下移	重度
椎间孔成形组	36	5.92 ± 1.22	6.92 ± 1.03	99.52 ± 10.62	33.38 ± 1.06	29	7
椎间孔未成形组	50	6.74 ± 0.92	7.07 ± 1.20	98.23 ± 8.77	32.69 ± 2.24	48	2
检验统计量		$t = -3.555$	$t = -0.606$	$t = 0.616$	$t = 1.713$		
P 值		0.004	0.566	0.739	0.164	0.031	

表 3 2 组 L<sub>5</sub>S<sub>1</sub> 腰椎间盘突出症患者影像学指标比较

组别	样本量 (例)	椎间隙高度 ( $\bar{x} \pm s$ , mm)	椎间孔宽度 ( $\bar{x} \pm s$ , mm)	椎板角 ( $\bar{x} \pm s$ , °)	髂嵴高度 ( $\bar{x} \pm s$ , mm)	突出椎间盘下移程度(例)	
						轻度或无下移	重度
椎间孔成形组	20	4.13 ± 1.22	5.89 ± 1.38	96.52 ± 8.62	35.26 ± 3.44	19	1
椎间孔未成形组	22	5.19 ± 0.92	7.28 ± 1.28	95.23 ± 6.77	32.78 ± 2.86	22	0
检验统计量		$t = -3.198$	$t = -3.387$	$t = 0.542$	$t = 2.549$		
P 值		0.006	0.002	0.173	0.001	0.476	

表 4 2 组中央型腰椎间盘突出症患者影像学指标比较

组别	样本量 (例)	椎间隙高度 ( $\bar{x} \pm s$ , mm)	椎间孔宽度 ( $\bar{x} \pm s$ , mm)	椎板角 ( $\bar{x} \pm s$ , °)	髂嵴高度 ( $\bar{x} \pm s$ , mm)	突出椎间盘下移程度(例)	
						轻度或无下移	重度
椎间孔成形组	10	5.66 ± 0.75	5.86 ± 1.46	103.58 ± 5.32	33.25 ± 2.01	9	1
椎间孔未成形组	12	6.93 ± 0.92	7.18 ± 1.41	92.38 ± 4.37	34.03 ± 1.63	12	0
检验统计量		$t = -3.499$	$t = -2.152$	$t = 5.426$	$t = 0.289$		
P 值		0.006	0.472	0.001	0.775	0.455	

道较为困难,因此部分临床医生建议采用经椎板间入路行 L<sub>5</sub>S<sub>1</sub> 椎间盘切除术<sup>[7-8]</sup>。但经椎板间入路手术存在手术时间长、术中透视次数多等缺点<sup>[9]</sup>,而且对突出椎间盘组织重度下移患者的疗效不佳<sup>[10]</sup>。经皮椎间孔成形术则使经椎间孔入路经皮内窥镜下切除 L<sub>5</sub>S<sub>1</sub> 突出髓核成为可能。对于中央型椎间盘突出,当患者的椎板角较大时,工作通道的接近角增大,镜下操作范围减小,无法进行有效减压;椎间孔成形术可有效减小工作通道的接近角,增加镜下的操作视野及范围。

当前,用来行经皮椎间孔成形术的手术器械主要有骨环锯和镜下动力磨钻<sup>[11-12]</sup>。使用骨环锯进行椎间孔成形耗时短、成本低,但需要在透视定位下进行操作,易损伤神经及硬膜囊,对术者的手术技巧要求较高。采用镜下动力磨钻,可有效获得术区的视野,安全性高,但成本较高、手术时间较长。本组均采用骨环锯行椎间孔成形术,未发生神经、硬膜囊损伤。Lee 等<sup>[13]</sup>的研究表明,运用骨环锯行椎间孔成形术时,骨环锯不超过患侧椎弓根内侧缘线可有效避免神经、硬膜囊损伤。对于不同类型的腰椎间盘突出,椎间孔成形术的方案也有差异。对于向下移位型椎间盘突出,需要磨除的是上关节突的基底部分;对于高髂嵴的 L<sub>5</sub>S<sub>1</sub> 椎间盘突出,需要磨除的是上关节突的尖

部;对于中央型椎间盘突出,需要磨除的是在椎间隙中线水平的关节突腹侧部分。

本研究的结果提示,病变节段椎间隙狭窄的腰椎间盘突出症、突出物向下移位严重的腰椎间盘突出症、髂嵴较高的 L<sub>5</sub>S<sub>1</sub> 椎间盘突出症、病变节段椎板角较大的中央型腰椎间盘突出症,均应视为经皮内窥镜下腰椎间盘切除术中椎间孔成形的适应证。

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