

## · 临床研究 ·

## 不同术式对多节段脊髓型颈椎病患者颈椎矢状位形态的矫形效果

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**【摘要】目的** 通过对比颈椎前路椎间盘切除融合术(ACDF)、椎板切除融合术(LCF)和椎板成形术(LP)后颈椎矢状位形态改变情况, 比较三者对多节段脊髓型颈椎病(MCSM)患者颈椎矢状位的矫形效果及对矫形效果的维持能力。**方法** 2016年1月—2019年12月, 首都医科大学宣武医院收治MCSM患者188例, 其中47例采用ACDF治疗(ACDF组)、72例采用LCF治疗(LCF组)、69例采用LP治疗(LP组)。根据术前颈椎前凸角(CL, C<sub>2-7</sub> Cobb角)将患者分为后凸型(CL<0°)、平直型(0°≤CL<10°)、前凸型(10°≤CL<20°)和过度前凸型(CL≥20°)。根据术前和术后CL计算不同术式的前凸改变量(末次随访CL-术前CL)、前凸矫正量(术后1周CL-术前CL)和前凸丢失量(术后1周CL-末次随访CL)。采用日本骨科学会(JOA)评分和颈椎功能障碍指数(NDI)评估临床疗效。**结果** 3组临床疗效差异无统计学意义。ACDF组前凸改变量、前凸矫正量大于LCF组和LP组, 差异均有统计学意义(P<0.05)。ACDF可增加后凸型、平直型和前凸型患者的CL, 随访中虽有部分丢失, 但至末次随访时矫形效果维持良好; 过度前凸型患者术后CL轻微增加, 但随访时逐渐减小, 过度前凸缓解。LCF可增加后凸型、平直型患者的CL, 随访中前凸丢失量少于ACDF, 但末次随访时矫形效果仍不如ACDF。LP术后各型患者CL均降低, 但随访过程中前凸丢失量小于ACDF和LCF。**结论** ACDF矫形能力较强, 可用于治疗各种颈椎曲度类型MCSM患者, LCF适用于后凸型、平直型MCSM患者, LP可用于治疗CL>10°的MCSM患者。MCSM手术方式的选择除常规考虑脊髓压迫位置、手术节段等, 还应考虑患者颈椎矢状位形态特点。

**【关键词】** 颈椎; 颈椎病; 椎间盘切除术; 椎板切除术; 脊柱融合术; 椎板成形术**【中图分类号】** R 681.531.1 **【文献标志码】** A **【文章编号】** 1672-2957(2022)05-0302-05**【DOI】** 10.3969/j.issn.1672-2957.2022.05.003**Orthopedic effect of different surgical methods for sagittal morphology of cervical spine in patients with multilevel cervical spondylotic myelopathy**Yuan Yi<sup>1</sup>, Li Xiangyu<sup>2</sup>, Liu Chengxin<sup>2</sup>, Shi Bin<sup>2</sup>, Wang Dongfan<sup>2</sup>, Wang Yu<sup>2</sup>, Kong Chao<sup>2</sup>, Lu Shibao<sup>2\*</sup>

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**【Abstract】Objective** To compare the changes of cervical sagittal morphology after anterior cervical discectomy and fusion(ACDF), laminectomy and fusion(LCF) and laminoplasty(LP), and to compare the orthopedic effect and its maintenance ability of the 3 methods on the sagittal morphology of multilevel cervical spondylotic myelopathy(MCSM) patients. **Methods** From January 2016 to December 2019, 188 patients with MCSM were treated in Xuanwu Hospital of Capital Medical University, of which 47 were treated with ACDF(ACDF group), 72 with LCF(LCF group) and 69 with LP(LP group). According to the preoperative cervical lordosis(CL, C<sub>2-7</sub> Cobb angle), the patients were divided into kyphosis type(CL<0°), straight type(0°≤CL<10°), lordosis type(10°≤CL<20°) and excessive lordosis type(CL≥20°). According to the preoperative and postoperative CL, the lordosis change(CL at final follow-up-preoperative CL), the lordosis correction(CL at postoperative 1 week-preoperative CL) and the lordosis loss(CL at postoperative 1 week-CL at final follow-up) were calculated. The clinical efficacy was evaluated by Japanese Orthopaedic Association(JOA) score and neck disability index(NDI).

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**Results** There was no significant difference in the clinical efficacy between the 3 groups. The amount of lordosis correction in ACDF group was greater than that in LCF group and LP group, and the differences were statistically significant ( $P < 0.05$ ). ACDF increased CL in kyphosis, straight and lordosis type patients, although CL was partially lost during follow-up, the orthopedic effect remained good until the final follow-up. In excessive lordosis type patients, the CL increased slightly after ACDF, but gradually decreased during follow-up, and the excessive lordosis was relieved. LCF increased CL in kyphosis and straight type patients. The amount of lordosis loss was less than that of ACDF during follow-up, but the orthopedic effect was still not as good as that of ACDF at the final follow-up. CL in all the types of patients after LP decreased, but the amount of lordosis loss was less than that of ACDF and LCF during follow-up. **Conclusions** ACDF has strong orthopedic ability and can be used to treat MCSM patients with various cervical curvature types. LCF is suitable for MCSM patients in kyphosis or straight type. LP can be used to treat MCSM patients with  $CL > 10^\circ$ . The selection of operation method for MCSM should not only consider the position of spinal cord compression and surgical segments, but also consider the cervical sagittal morphological characteristics.

**【Key Words】** Cervical vertebrae; Cervical spondylosis; Discectomy; Laminectomy; Spinal fusion; Laminoplasty

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脊髓型颈椎病(CSM)是高龄人群中常见的退行性疾病,可导致颈脊髓功能损伤并影响患者的感觉、运动功能,造成沉重的家庭和社会负担,非手术治疗无效时须手术治疗,通过直接或间接减压来改善硬膜囊的受压情况,但手术方式的选择仍然存在争议<sup>[1-2]</sup>。有研究<sup>[3-4]</sup>表明,前路手术比后路手术能够更好地改善CSM患者术后颈椎矢状位序列。Liang等<sup>[5]</sup>的研究表明,颈椎前路椎间盘切除融合术(ACDF)较椎板成形术(LP)保留颈椎前凸的能力差,仅推荐颈椎曲率指数 $< 20$ 的患者采用ACDF治疗。Kong等<sup>[6]</sup>则发现,颈椎前凸角(CL)与 $T_1$ 倾斜角比值小的患者采用椎板切除融合术(LCF)治疗能获得更好的矫正效果。Kuo等<sup>[7]</sup>的研究发现,颈椎椎间盘置换术后 $T_1$ 倾斜角大的患者CL减小, $T_1$ 倾斜角小的患者术后CL增大。不同术式的矫形能力存在差异,同时,手术方式的差异对CSM患者术后CL的保留能力也存在影响。本研究旨在进一步明确不同术式对多节段CSM(MCSM)患者颈椎矢状位形态的矫形能力及对矫形效果的维持能力,为手术方式的选择提供参考。

## 1 资料和方法

### 1.1 一般资料

纳入标准:①年龄 $\geq 18$ 岁;②影像学表现为颈椎脊髓硬膜囊压迫3个节段或以上;③至少有一种CSM的临床症状。排除标准:①既往有颈椎发育不良病史;②既往有恶性肿瘤病史;③既往有神经系统疾病史;④创伤后脊髓病患者;⑤既往有颈椎手术史。根据上述标准,共纳入2016年1月—2019年12月首都医科大学宣武医院收治的MCSM患者

188例,其中47例采用ACDF治疗(ACDF组)、72例采用LCF治疗(LCF组),69例采用LP治疗(LP组)。

### 1.2 影像学评估

分别在术前、术后1周及末次随访时测量颈椎矢状面参数。CL( $C_{2-7}$  Cobb角)为 $C_2$ 椎体下终板与 $C_7$ 椎体下终板的夹角。手术节段Cobb角为减压节段上位椎体下终板与减压节段下位椎体下终板间的夹角。颈椎矢状面轴向距离(CSVA)为 $C_7$ 椎体上终板后端与 $C_2$ 椎体中心垂直线间的距离。 $T_1$ 倾斜角为水平面与 $T_1$ 上终板平行线间的夹角。所有数据均由2名脊柱外科医师独立测量、计算并取平均值。

根据术前和术后CL计算不同术式的前凸改变量(末次随访CL-术前CL)、前凸矫正量(术后1周CL-术前CL)和前凸保留量(末次随访CL-术后1周CL)。

### 1.3 疗效评价

采用日本骨科学会(JOA)评分<sup>[8]</sup>和颈椎功能障碍指数(NDI)<sup>[9]</sup>评估手术疗效。JOA评分改善率( $\%$ )=(末次随访JOA评分-术前JOA评分)/(17-术前JOA评分) $\times 100\%$ 。

### 1.4 统计学处理

采用SPSS 22.0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,采用单因素方差分析进行组间比较;不符合正态分布的计量资料以中位数和四分位数表示,采用Kruskal-Wallis H检验进行组间比较。计数资料以例数或百分数表示,采用 $\chi^2$ 检验进行组间比较。以 $P < 0.05$ 为差异有统计学意义。

2 结 果

2.1 各组影像学参数及临床疗效

LCF组患者年龄大于ACDF组和LP组, LP组男性多于ACDF组和LCF组, LCF组手术节段多于ACDF组和LP组, 差异均有统计学意义( $P<0.05$ , 表1)。ACDF组患者术前JOA评分高于LCF组和LP

组, 但各组JOA评分改善率差异无统计学意义( $P>0.05$ , 表1)。各组术前及末次随访时NDI差异均无统计学意义( $P>0.05$ , 表1)。各组术前CL、 $T_1$ 倾斜角、CSVA、手术节段Cobb角差异无统计学意义( $P>0.05$ , 表1), 术后1周及末次随访时ACDF组CL、 $T_1$ 倾斜角、手术节段Cobb角均大于LCF组和LP组, CSVA低于LCF组和LP组, 差异均有统计学意义( $P<0.05$ , 表1)。

表1 3组影像学参数及临床疗效  
Tab. 1 Imaging parameters and clinical efficacy of 3 groups

| 组别<br>Group | <i>n</i> | 年龄/岁<br>Age/year          | 男性<br>Male               | 手术节段数量<br>Number of<br>operative segments | 随访时间/月<br>Follow-up<br>time/month | JOA 评分<br>JOA score |                         |                               |
|-------------|----------|---------------------------|--------------------------|-------------------------------------------|-----------------------------------|---------------------|-------------------------|-------------------------------|
|             |          |                           |                          |                                           |                                   | 术前<br>Pre-operation | 末次随访<br>Final follow-up | 改善率(%)<br>Improvement rate(%) |
| ACDF        | 47       | 59.91 ± 10.85             | 23( 48.9%)               | 3.32 ± 0.52                               | 18.46 ± 7.87                      | 11.40 ± 1.86        | 14.87 ± 1.86            | 65.88 ± 23.32                 |
| LCF         | 72       | 63.67 ± 9.24*             | 45( 62.5%)               | 4.01 ± 0.72*                              | 19.43 ± 6.58                      | 10.57 ± 1.70*       | 14.31 ± 1.92            | 61.33 ± 21.18                 |
| LP          | 69       | 58.17 ± 9.04 <sup>△</sup> | 51( 73.9%)* <sup>△</sup> | 3.51 ± 0.66 <sup>△</sup>                  | 19.07 ± 6.52                      | 10.68 ± 1.77*       | 14.26 ± 2.24            | 60.82 ± 27.28                 |

| 组别<br>Group | NDI                  |                         | CL/(°)              |                                 |                            | $T_1$ 倾斜角/(°)<br>$T_1$ slope/(°) |                                 |                            |
|-------------|----------------------|-------------------------|---------------------|---------------------------------|----------------------------|----------------------------------|---------------------------------|----------------------------|
|             | 术前<br>Pre-operation  | 末次随访<br>Final follow-up | 术前<br>Pre-operation | 术后1周<br>Postoperative<br>1 week | 末次随访<br>Final<br>follow-up | 术前<br>Pre-operation              | 术后1周<br>Postoperative<br>1 week | 末次随访<br>Final<br>follow-up |
| ACDF        | 20.00( 4.00, 40.00 ) | 2.00( 0.00, 4.00 )      | 14.13 ± 11.90       | 20.20 ± 9.59                    | 19.25 ± 8.78               | 25.79 ± 8.59                     | 28.61 ± 7.30                    | 26.78 ± 7.24               |
| LCF         | 21.00( 4.00, 40.00 ) | 2.00( 0.00, 4.00 )      | 15.85 ± 9.10        | 12.15 ± 9.71*                   | 10.20 ± 8.71*              | 24.38 ± 7.15                     | 25.21 ± 7.84*                   | 23.11 ± 7.27*              |
| LP          | 21.00( 4.00, 32.00 ) | 2.00( 0.00, 4.00 )      | 18.33 ± 10.44       | 10.51 ± 10.55*                  | 10.97 ± 9.19*              | 23.94 ± 7.27                     | 23.06 ± 7.17*                   | 21.60 ± 6.28*              |

| 组别<br>Group | CSVA/mm             |                              |                         | 手术节段Cobb角/(°)<br>Cobb angle of operated segments/(°) |                              |                         |
|-------------|---------------------|------------------------------|-------------------------|------------------------------------------------------|------------------------------|-------------------------|
|             | 术前<br>Pre-operation | 术后1周<br>Postoperative 1 week | 末次随访<br>Final follow-up | 术前<br>Pre-operation                                  | 术后1周<br>Postoperative 1 week | 末次随访<br>Final follow-up |
| ACDF        | 15.72 ± 10.92       | 16.97 ± 11.41                | 13.75 ± 8.24            | 11.71 ± 10.63                                        | 18.89 ± 8.93                 | 16.62 ± 9.89            |
| LCF         | 20.33 ± 10.89       | 27.48 ± 13.33*               | 26.43 ± 12.97*          | 8.43 ± 8.84                                          | 6.01 ± 8.90*                 | 4.19 ± 7.78*            |
| LP          | 16.93 ± 12.51       | 28.75 ± 16.67*               | 25.71 ± 14.00*          | 9.14 ± 8.36                                          | 6.52 ± 8.40*                 | 6.09 ± 8.02*            |

注: \*与ACDF组比较,  $P<0.05$ ;  $\Delta$ 与LCF组比较,  $P<0.05$ 。  
Note: \*  $P<0.05$ , compared with ACDF group;  $\Delta$   $P<0.05$ , compared with LCF group.

2.2 各组矫形能力及对矫形效果的维持能力

ACDF组的前凸改变量、前凸矫正量大于LCF组和LP组, LP组的前凸丢失量小于ACDF组和LCF组, 差异均有统计学意义( $P<0.05$ , 表2)。根据患者术前CL将患者分为4种类型: 后凸型( $CL<0^\circ$ )、平直型( $0^\circ \leq CL<10^\circ$ )、前凸型( $10^\circ \leq CL<20^\circ$ )和过度前凸型( $CL \geq 20^\circ$ )。结果显示, ACDF可增加后凸型、平

直型和前凸型患者的CL, 随访中虽有部分丢失, 但至末次随访时矫形效果维持良好; 过度前凸型患者术后CL轻微增加, 但随访时逐渐减小, 过度前凸缓解(表3)。LCF可增加后凸型、平直型患者的CL, 随访中前凸丢失量少于ACDF, 但末次随访时矫形效果仍不如ACDF(表3)。LP术后各型患者CL均降低, 但随访过程中前凸丢失量小于ACDF和LCF(表3)。

表2 3种术式矫形能力及对矫形效果的维持能力

Tab. 2 Orthopedic effect and maintenance ability of 3 surgical methods

| 组别<br>Group | <i>n</i> | 前凸改变量/(°)<br>Lordosis change/(°) | 前凸矫正量/(°)<br>Lordosis correction/(°) | 前凸丢失量/(°)<br>Lordosis loss/(°) |
|-------------|----------|----------------------------------|--------------------------------------|--------------------------------|
| ACDF        | 47       | 5.13 ± 11.04                     | 6.08 ± 8.66                          | 0.94 ± 7.94                    |
| LCF         | 72       | -5.65 ± 9.13*                    | -3.70 ± 9.11*                        | 1.94 ± 4.47                    |
| LP          | 69       | -7.36 ± 9.54*                    | -7.83 ± 9.90*                        | -0.47 ± 4.72* <sup>△</sup>     |

注: \*与ACDF组比较,  $P < 0.05$ ; <sup>△</sup>与LCF组比较,  $P < 0.05$ 。

Note: \*  $P < 0.05$ , compared with ACDF group; <sup>△</sup>  $P < 0.05$ , compared with LCF group.

表3 3种术式对不同类型患者的矫形能力及对矫形效果的维持能力

Tab. 3 Orthopedic effect and its maintenance ability of 3 surgical methods for different types of patients

| 组别<br>Group | <i>n</i> | 前凸改变量/(°)<br>Lordosis change/(°)   |                                            |                                            |                                |
|-------------|----------|------------------------------------|--------------------------------------------|--------------------------------------------|--------------------------------|
|             |          | 后凸<br>Kyphosis                     | 平直<br>Straight                             | 前凸<br>Lordosis                             | 过度前凸<br>Excessive lordosis     |
| ACDF        | 47       | 17.18 ± 13.10( <i>n</i> =5 )       | 12.03 ± 7.34( <i>n</i> =12 )               | 5.68 ± 8.27( <i>n</i> =15 )                | -4.9 ± 6.22( <i>n</i> =15 )    |
| LCF         | 72       | 4.42 ± 5.69( <i>n</i> =3 )*        | 2.21 ± 8.57( <i>n</i> =13 )*               | -6.36 ± 8.23( <i>n</i> =31 )*              | -10.06 ± 7.44( <i>n</i> =25 )* |
| LP          | 69       | -5.70( <i>n</i> =1 )* <sup>△</sup> | -3.12 ± 7.11( <i>n</i> =17 )* <sup>△</sup> | -2.66 ± 7.07( <i>n</i> =18 )* <sup>△</sup> | -12.15 ± 9.79( <i>n</i> =33 )* |

  

| 组别<br>Group | 前凸矫正量/(°)<br>Lordosis correction/(°) |                                            |                               |                                 |
|-------------|--------------------------------------|--------------------------------------------|-------------------------------|---------------------------------|
|             | 后凸<br>Kyphosis                       | 平直<br>Straight                             | 前凸<br>Lordosis                | 过度前凸<br>Excessive lordosis      |
| ACDF        | 14.66 ± 6.66( <i>n</i> =5 )          | 10.97 ± 7.43( <i>n</i> =12 )               | 4.40 ± 8.87( <i>n</i> =15 )   | 0.97 ± 5.84( <i>n</i> =15 )     |
| LCF         | 2.94 ± 4.94( <i>n</i> =3 )*          | 3.16 ± 8.62( <i>n</i> =13 )*               | -4.55 ± 7.85( <i>n</i> =31 )* | -7.02 ± 9.27( <i>n</i> =25 )*   |
| LP          | -7.10( <i>n</i> =1 )* <sup>△</sup>   | -2.80 ± 7.97( <i>n</i> =17 )* <sup>△</sup> | -6.06 ± 6.83( <i>n</i> =18 )* | -11.14 ± 11.12( <i>n</i> =33 )* |

  

| 组别<br>Group | 前凸丢失量/(°)<br>Lordosis loss/(°) |                              |                                           |                              |
|-------------|--------------------------------|------------------------------|-------------------------------------------|------------------------------|
|             | 后凸<br>Kyphosis                 | 平直<br>Straight               | 前凸<br>Lordosis                            | 过度前凸<br>Excessive lordosis   |
| ACDF        | -2.52 ± 10.14( <i>n</i> =5 )   | -1.06 ± 6.77( <i>n</i> =12 ) | -1.27 ± 5.75( <i>n</i> =15 )              | 5.92 ± 8.32( <i>n</i> =15 )  |
| LCF         | -1.47 ± 2.15( <i>n</i> =3 )    | 0.95 ± 0.91( <i>n</i> =13 )  | 1.81 ± 4.89( <i>n</i> =31 )               | 3.04 ± 5.01( <i>n</i> =25 )  |
| LP          | -1.40( <i>n</i> =1 )           | 1.94 ± 4.47( <i>n</i> =17 )  | -3.40 ± 3.84( <i>n</i> =18 ) <sup>△</sup> | 0.75 ± 5.29( <i>n</i> =33 )* |

注: \*与ACDF组比较,  $P < 0.05$ ; <sup>△</sup>与LCF组比较,  $P < 0.05$ 。

Note: \*  $P < 0.05$ , compared with ACDF group; <sup>△</sup>  $P < 0.05$ , compared with LCF group.

### 3 讨 论

MCSM手术治疗的目的是脊髓减压、恢复CL并避免后凸畸形的出现。矫形能力和矫形效果保留能力是评估手术效果的重要指标。一般来说, 脊髓减压的程度与范围决定了神经功能恢复的上限, 同时, 术后颈椎矢状位的力线恢复及维持是保证患者颈部功能的基础。有研究<sup>[10-13]</sup>表明, ACDF、LP及

LCF术后CL的变化存在差异, ACDF较LP和LCF能更好地改善CL。

有研究<sup>[14]</sup>表明, 术前CL较大的患者LP术后有更好的临床及影像学预后, CL>20°的患者采用LP治疗, 术后疼痛程度较采用LCF治疗的患者轻; 对于曲率指数>20的患者, LP较ACDF能更好地保留CL<sup>[5]</sup>。本研究结果显示, 末次随访时LP组各型(后凸型、平直型、前凸型和过度前凸型)患者CL均较

小, 因此, 对平直型、前凸型和过度前凸型患者, 不推荐采用LP治疗。LCF和ACDF均为融合手术, 对颈椎序列具有矫形能力, 可改善后凸型、平直型患者颈椎的矢状面形态, 且ACDF的矫形能力优于LCF, 这与既往Cabreja等<sup>[3]</sup>的研究一致。Wang等<sup>[11]</sup>的研究发现, LCF组和ACDF组术后1周、3个月、6个月、12个月CL均有所增加, 但在术后18个月和24个月时出现下降。Guo等<sup>[15]</sup>发现, 3个节段行ACDF, 术后CL维持较差。目前, 融合术后CL丢失的原因尚不清楚, 植骨不融合、融合器下沉、椎间盘高度丧失或邻近节段病变等均可能导致CL丧失, 其机制有待进一步研究。

颈椎手术的人路决定了减压的方式, 颈椎前路手术为直接减压, 颈椎后路手术通过脊髓漂移实现间接减压, 通常术前评估脊髓压迫位置及节段数量作为术式选择的参考依据<sup>[16-18]</sup>。对于前凸型MCSM患者, 建议采用较为简便的后路手术; 对于1~3个节段、后凸型CSM患者, 建议采用矫正能力较强的前路手术。随着手术技术的发展, 前路减压手术也被广泛用于治疗MCSM。也有研究<sup>[19-20]</sup>指出, 对T<sub>1</sub>倾斜角大的患者采用前路手术治疗, 其颈椎平衡维持更好, 临床效果更佳。本研究结果显示, ACDF具有显著的矫形能力, 对于不同颈椎曲度类型的患者, 均可采用ACDF治疗; LCF也有较好的矫形能力, 推荐用于后凸型和平直型CMS患者; LP矫形能力较差, CL>10°的患者可采用LP治疗。

本研究为回顾性研究, 病例纳入可能存在选择偏倚, 患者的特征差异可能会影响结果。由于缺乏患者队列, 本研究将3个节段及以上的患者一起分析。手术方法的选择根据患者自身特点和术者经验, 虽没有收集决策过程的细节, 但可以保证医师的决策过程是无利益相关的。同时, 本研究随访时间相对较短, 未来仍需要更长的随访时间和更大样本量来证实本研究的结论。最后, 由于部分患者缺乏脊柱全长X线片, 本研究未考虑脊柱整体矢状面平衡对术后颈椎矢状位形态的影响, 这也是需要进一步研究的问题。

综上, ACDF矫形能力较强, 可用于治疗各种颈椎曲度类型MCSM患者; LCF适用于后凸型、平直型MCSM患者; LP可用于治疗CL>10°的MCSM患者。MCSM手术方式的选择除常规考虑脊髓压迫位置、手术节段等, 还应考虑患者颈椎矢状位形态特点。

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