

临床论著

C2 及 C7 倾斜角与退变性颈椎节段后凸矢状位力线及临床功能相关性研究

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【摘要】目的:分析退变性颈椎节段后凸患者行颈椎前路减压融合术前及术后 C2 倾斜角(slope)、C7 slope 与颈椎矢状位力线和临床功能的相关性。**方法:**回顾性分析我院 2015 年 1 月~2020 年 3 月因颈椎退变性疾病入院行颈椎前路减压融合术的患者。定义颈椎后凸角度为正值,颈椎前凸角度为负值。依据颈椎标准侧位 X 线片,将颈椎节段后凸角度大于 4°者纳入退变性颈椎节段后凸组,使用倾向性评分 1:1 匹配颈椎前凸组患者,匹配因素包括年龄、性别、手术节段和数量及内固定方式。共纳入 146 例患者,包括退变性颈椎节段后凸组患者及匹配的颈椎前凸组患者各 73 例。退变性颈椎节段后凸组中,S 型 42 例,R 型 31 例。测量患者术前和术后 1 年随访时的 C2 slope、C7 slope、C2-C7 曲度、颈椎融合节段角度及 C2-C7 矢状位垂直轴(sagittal vertical axis, SVA),记录术前和术后 1 年随访时的疼痛视觉模拟评分(visual analogue scale, VAS)、颈椎功能障碍指数(neck disability index, NDI)及日本骨科学会(Japanese Orthopaedic Association, JOA)评分。使用 Pearson 相关分析术前和术后 1 年随访时的 C2 slope、C7 slope 与 C2-C7 曲度、颈椎融合节段角度、C2-C7 SVA、VAS、NDI、JOA 评分的相关性。**结果:**退变性颈椎节段后凸组患者,术前 C2 slope 与术前 NDI 呈正相关($r=0.433, P<0.001$),术后 1 年 C2 slope 与术后 1 年 NDI 呈正相关($r=0.334, P=0.004$);术前 C7 slope 与术前 C2-C7 SVA 呈正相关($r=0.595, P<0.001$),与术后 1 年融合节段角度呈负相关($r=-0.617, P<0.001$)。颈椎前凸组患者,术前 C2 slope 与术前 NDI 无明显相关($P>0.05$),术前 C7 slope 与术后 1 年融合节段角度无明显相关($P>0.05$)。两组患者术前及术后 1 年随访 C2 slope 和 C7 slope 与术前及术后 1 年随访 VAS 和 JOA 评分均无明显相关($P>0.05$)。**结论:**与颈椎前凸患者不同,在退变性颈椎节段后凸患者中,C2 slope 越大,则相应的颈椎功能越差;而术前 C7 slope 越大,则术后颈椎整体及融合节段前凸角度越大。

【关键词】颈椎退变性疾病;颈椎节段后凸;颈椎矢状位力线;C2 倾斜角;C7 倾斜角

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【Abstract】Objectives: To analyze the associations between C2 slope, C7 slope and sagittal alignment, clinical outcomes in patients with degenerative cervical focal kyphosis patients. **Methods:** A retrospective study was conducted among patients underwent anterior cervical decompression and fusion for cervical degenerative disease between January 2015 and March 2020 in our hospital. The angle of cervical kyphosis was set as a positive value and the angle of lordosis as a negative value. Degenerative cervical focal kyphosis group was defined as cervical focal kyphosis angle $>4^\circ$. After 1:1 propensity score matching, cervical lordosis group was determined, based on the age, sex, distribution of the levels treated, number of segments fused and type of instrument. A total of 146 patients were involved. There were 73 patients with degenerative cervical focal

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kyphosis, including 42 S-type and 31 R-type patients, and 73 patients with cervical lordosis. C2 slope, C7 slope, C2-C7 curve, cervical focal angle of fused levels, and C2-C7 sagittal vertical axis (SVA) were measured, visual analogue scale (VAS), neck disability index (NDI), Japanese Orthopaedic Association (JOA) score were obtained before surgery and at 1-year visit after discharge. Pearson correlation analyses were performed between C2 slope, C7 slope and C2-C7 curve, cervical focal angle of fused levels, C2-C7 SVA, VAS, NDI, JOA score before surgery and at 1-year visit after discharge. **Results:** Positive correlation was found between preoperative C2 slope and preoperative NDI in patients with degenerative cervical kyphosis ($r=0.433$, $P<0.001$), so was there at postoperative 1-year visit ($r=0.334$, $P=0.004$). Positive correlation was found between preoperative C7 slope and preoperative 1-year visit C2-C7 SVA in patients with degenerative cervical focal kyphosis ($r=0.595$, $P<0.001$). Negative correlation was found between preoperative C7 slope and postoperative 1-year visit focal angle of fused levels in patients with degenerative cervical focal kyphosis ($r=-0.617$, $P<0.001$). There was no correlation between preoperative C2 slope and preoperative NDI in patients with cervical lordosis ($P>0.05$). There was no correlation between preoperative C7 slope and postoperative 1-year visit focal angle of fused levels in patients with cervical lordosis ($P>0.05$). There was no correlation between preoperative or postoperative 1-year visit C2 slope or C7 slope and VAS or JOA scores ($P>0.05$). **Conclusions:** In patients with degenerative cervical focal kyphosis, preoperative and postoperative C2 slope correlates with worse clinical outcomes postoperative C7 slope correlates with larger postoperative cervical global lordosis and focal lordosis of fused levels. Such correlations could not be found in patients with cervical lordosis.

[Key words] Cervical degenerative disease; Cervical focal kyphosis; Cervical sagittal alignment; C2 slope; C7 slope

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颈椎退变性疾病患者中约 10%~40% 患者可出现退变性颈椎后凸^[1-2]。退变性颈椎后凸按形态学分型可分为 S 型、R 型及 C 型, 其中 S 型、R 型后凸属于颈椎节段后凸^[3-4]。评估方法包括 C2-C7 曲度或节段角度^[5,6]、C2-C7 矢状位垂直轴 (sagittal vertical axis, SVA)^[1]、C2 倾斜角 (C2 slope) 和 T1 slope^[7]等。T1 slope 是评估颈椎矢状位力线的重要参数, 与 C2-C7 曲度及 C2-C7 SVA 相关, 对术后颈椎曲度变化有预测作用^[8-10]。有研究认为 T1 slope 与术后颈椎整体或节段曲度呈正相关, 但也有研究结果与之相左, 认为应该呈负相关^[8-13]。因肩部遮挡的原因, C7 slope 可以替代 T1 slope, 并能够达到与之接近的评估效果^[14]。C2 slope 值与 T1 slope 减 C2-C7 曲度的差值接近, 并与临床功能相关^[15,16]。但已有相关研究结论并不一致, 也有研究认为 C2 slope 与临床功能并无相关^[17-19]。C2 slope 与 T1 slope 在退变性颈椎节段后凸中的评估价值以及既往研究结果存在争议的原因需进一步明确。本研究通过对退变性颈椎节段后凸患者术前及术后 1 年随访时的矢状位力线及临床功能评分进行分析, 1:1 匹配颈椎前凸组患者进行对

比, 试图探讨退变性颈椎节段后凸患者行颈椎前路减压融合术前及术后 C2 slope、C7 slope 与颈椎矢状位力线和临床功能的相关性。

1 资料与方法

1.1 一般资料

回顾性分析我院 2015 年 1 月~2020 年 3 月, 因颈椎退变性疾病入院行颈椎前路减压融合术 (anterior cervical decompression and fusion, ACDF) 的患者。定义颈椎后凸角度为正值, 颈椎前凸角度为负值。依据颈椎标准侧位 X 线片, 将颈椎节段后凸角度 $>4^\circ$ 者纳入退变性颈椎节段后凸组, 包含 S 型及 R 型节段后凸^[3,4,20,21], 其中 S 型为头端前凸尾端后凸的节段性后凸, R 型为头端后凸尾端前凸的节段性后凸; 无颈椎节段后凸且 C2-C7 整体曲度 $<-4^\circ$ 者纳入颈椎前凸组 (图 1)。

排除标准: (1) 颈椎外伤、肿瘤、感染及手术史; (2) 颈椎先天性融合或分节不良; (3) 颈椎后纵韧带骨化; (4) 弥漫性特发性骨质增生症; (5) 行颈椎前路椎体次全切除术或颈椎后路手术治疗; (6) 术后 1 年随访时融合节段假关节形成; (7) 影像资

料、临床评估不完整或 1 年随访时失访。

最终纳入退变性颈椎节段后凸组患者 73 例(双节段 59 例,三节段 14 例)。使用倾向性评分 1:1 匹配颈椎前凸组患者 73 例,匹配因素包括年龄、性别、手术节段和数量以及内固定方式。本研究通过了医学伦理委员会批准(伦理号 1:#KY2014-025-02)。共纳入 146 例患者,包括退变性颈椎节段后凸组患者及颈椎前凸组患者各 73 例。退变性颈椎节段后凸组患者年龄 52.8 ± 10.8 岁(30~73 岁),S 型退变性颈椎节段后凸 42 例、R 型退变性颈椎节段后凸 31 例。

1.2 手术方式

所有手术由本单位同一高年资脊柱外科医师主刀完成。全身麻醉后,患者平卧、颈部轻度后伸位,常规术中电生理监测。选择右侧横切口,术中 C 型臂 X 线机透视明确定位。术中充分减压脊髓及神经根,椎间处理去除软骨终板保留骨性终板,减小融合器下沉风险。选择合适高度和大小的零切迹自锁型融合器(LDR Medical Company, France)或钛板椎间融合器(Solis, Stryker Corporation, USA),填充混合自体血的人工骨颗粒(Mastergraft, Medtronic, USA)后置入相应减压节段。C 型臂 X 线机再次确认手术节段及内固定位置。术后嘱患者佩戴颈托 4 周。

1.3 观察指标

获得患者术前和术后 1 年随访时的影像资料及临床评估资料。影像资料包括颈椎正侧位及动力位 X 线片,动力位 X 线片用于评估颈椎融合情况^[22]。如果术后 1 年随访动力位 X 线检查怀疑假关节形成,则行颈椎 CT 检查进一步明确。临床功能评估使用疼痛视觉模拟评分(visual analogue scale, VAS)、颈椎功能障碍指数(neck disability index, NDI)及日本骨科学会(Japanese Orthopaedic Association, JOA)评分。

颈椎 X 线摄片时患者标准直立体位,双肩下垂,听鼻线平行于水平面,左侧身体靠近 X 线胶片,光束聚焦 C4 椎体水平,X 线管球和胶片的距离是 150cm,获得标准侧位 X 线片。活动度测量选用主动活动度,要求患者尽量弯曲颈部得到前屈位,尽量后伸颈部得到后伸位 X 线影像。所有影像摄片均采用相同数字放射成像设备(GE Discovery XR656, USA)。

所有影像导入影像测量软件(OsiriX MD, Version 9.5.1, Pixmeo SARL, Geneva, Switzerland)。所有影像参数由两位脊柱外科医生间隔 2 周分别测量 2 次,2 次测量过程中隐藏患者个人信息,并计算测量结果的组间及组内一致性。分别测量患者术前和术后 1 年随访时 C2-C7 曲度、颈椎融合节段角度、C2 slope、C7 slope 及 C2-C7 SVA(图 2、3)。C2-C7 曲度及融合节段角度测量采用 Cobb



图 1 不同类型颈椎矢状位形态分型 a 颈椎前凸 b S 型后凸,表现为头端前凸尾端后凸的节段性后凸 c R 型后凸,表现为头端后凸尾端前凸的节段性后凸

Figure 1 Cervical sagittal alignment was morphologically classified into 5 types **a** Cervical lordosis **b** S-type cervical kyphosis, the kind of cervical spine with cranial lordosis and caudal kyphosis **c** R-type cervical kyphosis, the kind with cranial kyphosis and caudal lordosis

角法^[6]。

1.4 统计学分析

采用 SPSS 26.0 统计软件 (IBM SPSS Inc., USA) 进行统计学分析, 计量资料采用平均数 (M) $\pm$ 标准差 (SD) 表示。连续性变量组间比较使用 *t* 检验, 非正态分布变量组间比较使用 Wilcoxon 符号秩检验。Pearson 相关用于评估术前和术后 1 年随访时的 C2 slope、C7 slope 与 C2-C7 曲度、颈椎融合节段角度、C2-C7 SVA、VAS、NDI、JOA 评分的相关性。采用类内相关系数 (ICC) 评价测量者组间和组内一致性。 $P < 0.05$ 认为有统计学意义。

2 结果

2.1 一致性检验

C2-C7 曲度、融合节段角度、C2-C7 SVA、C2 slope 以及 C7 slope 的测量, 测量者间有良好的组间一致性 (ICC=0.80~0.88) 和良好的组内一致性 (ICC=0.88~0.95)。

2.2 影像学测量

退变性颈椎节段后凸组及颈椎前凸组患者术前与术后 1 年时的 C2-C7 曲度、融合节段角度、C2 slope、C7 slope 及 C2-C7 SVA 见表 1。退变性颈椎节段后凸组患者及颈椎前凸组患者的术后 1 年 C2-C7 整体曲度、融合节段角度均较术前显著改善 ($P < 0.05$); 退变性颈椎节段后凸组患者术后 1 年 C2 slope 较术前显著减小 ($P < 0.05$), 颈椎前凸组患者术前与术后 1 年 C2 slope 差异无统计学意义 ($P > 0.05$); 退变性颈椎节段后凸组患者术后 1 年 C7 slope 较术前显著增大 ($P < 0.05$), 颈椎前凸组患者术前与术后 1 年 C7 slope 差异无统计学意义 ($P > 0.05$); 退变性颈椎节段后凸组患者及颈椎前凸组患者的术前与术后 1 年 C2-C7 SVA 差异均无统计学意义 ($P > 0.05$)。

2.3 临床功能评分

退变性颈椎节段后凸组与颈椎前凸组患者的术后 1 年上肢 VAS 评分、NDI、JOA 评分均较术前明显改善 ($P < 0.05$, 表 2)。

2.4 C2 slope 及 C7 slope 与颈椎矢状位力线及

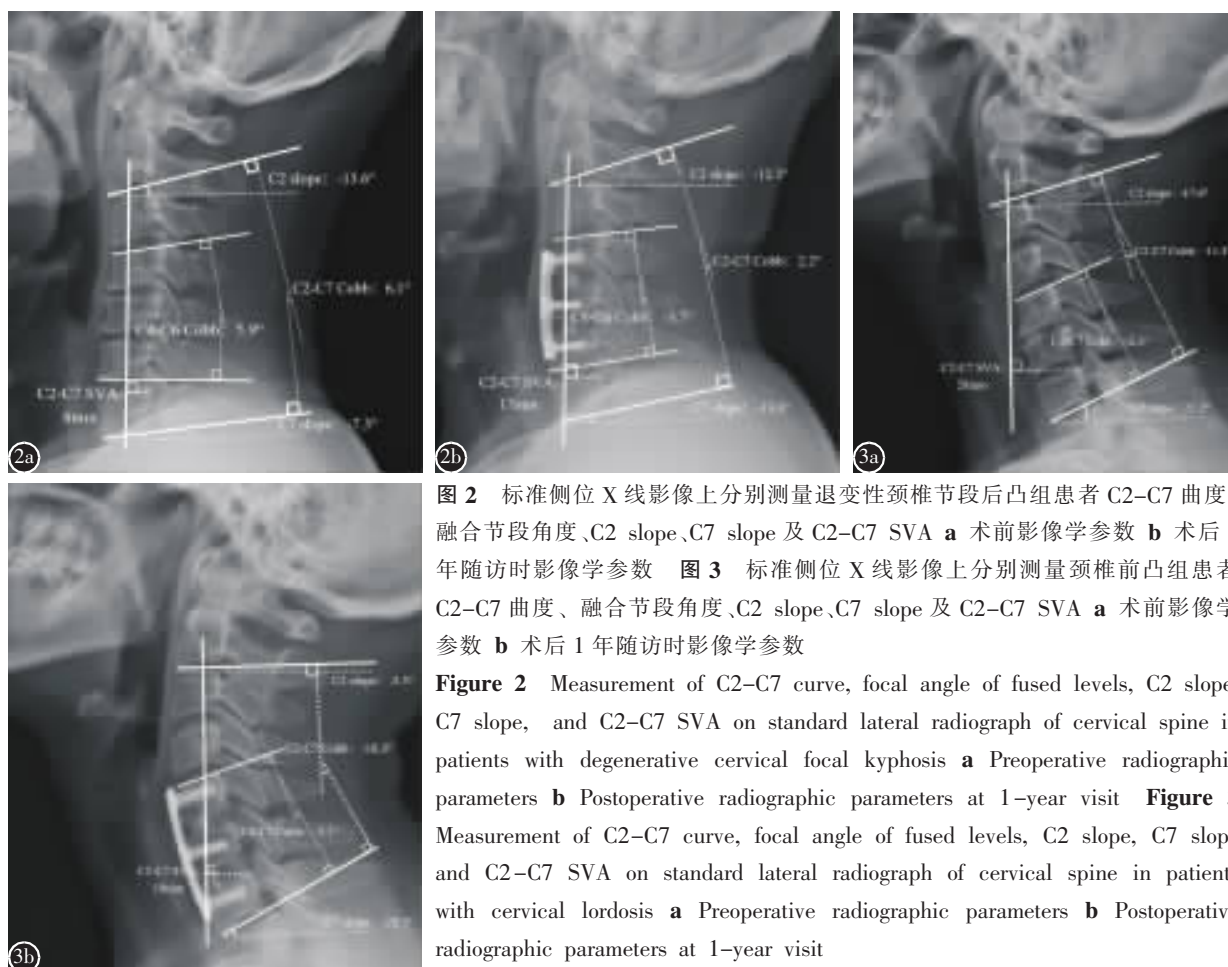


图 2 标准侧位 X 线影像上分别测量退变性颈椎节段后凸组患者 C2-C7 曲度、融合节段角度、C2 slope、C7 slope 及 C2-C7 SVA a 术前影像学参数 b 术后 1 年随访时影像学参数 图 3 标准侧位 X 线影像上分别测量颈椎前凸组患者 C2-C7 曲度、融合节段角度、C2 slope、C7 slope 及 C2-C7 SVA a 术前影像学参数 b 术后 1 年随访时影像学参数

Figure 2 Measurement of C2-C7 curve, focal angle of fused levels, C2 slope, C7 slope, and C2-C7 SVA on standard lateral radiograph of cervical spine in patients with degenerative cervical focal kyphosis **a** Preoperative radiographic parameters **b** Postoperative radiographic parameters at 1-year visit **Figure 3** Measurement of C2-C7 curve, focal angle of fused levels, C2 slope, C7 slope and C2-C7 SVA on standard lateral radiograph of cervical spine in patients with cervical lordosis **a** Preoperative radiographic parameters **b** Postoperative radiographic parameters at 1-year visit

临床功能的关系

退变性颈椎节段后凸组患者的术前 C2 slope 与术前 NDI 呈正相关($P<0.05$);术前 C7 slope 与术前 C2-C7 SVA 及术后 1 年 C2-C7 SVA 呈正相关($P<0.05$),与术后 1 年 C2-C7 曲度及融合节段角度呈负相关($P<0.05$,表 3)。颈椎前凸组患者术前的 C2 slope 与术前 NDI 无明显相关 ($P>0.05$),术前 C7 slope 与术后 1 年 C2-C7 SVA 及术后 1 年融合节段角度无明显相关 ($P>0.05$,表

表 1 退变性颈椎节段后凸组与颈椎前凸组的术前、术后影像学参数对比

Table 1 Comparison between preoperative and postoperative radiographic parameters in both groups

	术前 Preoperation	术后 1 年 1-year visit postoperation
退变性颈椎节段后凸组 Degenerative cervical focal kyphosis group		
C2-C7 曲度(°) C2-C7 curve	-4.2±8.0	-10.1±9.3 ^①
融合节段角度(°) Focal angle of fused levels	9.4±4.5	-2.6±6.2 ^①
C2 倾斜角 C2 slope(°)	10.5±4.7	8.8±5.4 ^①
C7 倾斜角 C7 slope(°)	14.4±6.3	19.0±5.2 ^①
C2-C7 矢状位垂直轴 C2-C7 SVA (mm)	20.6±10.2	19.5±8.0
颈椎前凸组 Cervical lordosis group		
C2-C7 曲度(°) C2-C7 curve	-17.4±7.2	-20.2±10.8 ^①
融合节段角度(°) Focal angle of fused levels	-3.8±1.7	-5.9±6.1 ^①
C2 倾斜角 C2 slope(°)	0.9±6.5	-0.1±4.7
C7 倾斜角 C7 slope(°)	19.1±6.9	21.5±12.0
C2-C7 矢状位垂直轴 C2-C7 SVA(mm)	15.7±8.0	16.7±5.1

注:①与术前相比 $P<0.05$

Note: ①Compared with that preoperatively, $P<0.05$

3)。两组患者中仅退变性颈椎后凸组,术后 1 年 C2 slope 与术后 1 年 NDI 相关($P<0.05$);术后 1 年 C2-C7 SVA 与术后 1 年随访 VAS、NDI 相关($P<0.05$,表 4)。

3 讨论

颈椎曲度和矢状位力线是临床上对退变性颈椎后凸最常用的评估方法,并与临床功能及生活质量相关^[1,5,6,23-25]。为维持整体矢状位平衡及平视功能,颈椎矢状位力线与毗邻的颈胸交界区及颅颈交界区矢状位力线密切相关,包括 C2 slope 以及 C7 slope 或 T1 slope^[19,26-28]。

Knott 等^[7]学者研究发现,T1 slope 与 C7-S1 SVA 相关。还有研究认为,T1 slope 与 C2-C7 SVA 相关,并与生活质量相关, $>40^\circ$ 的 T1 slope 代表着更差的生活质量^[8,29]。因为 T1 slope 很多时候在颈椎侧位 X 线片上都因肩部遮挡而无法测量,且 C7-T1 之间节段曲度和活动度相对较小。有学者尝试用 C7 slope 替代 T1 slope 对患者进行评估,发现 C7 slope 能够达到与 T1 slope 接近的评估效果^[14]。术前 T1 slope 还能够对术后颈椎曲度变化起到预测作用^[8-13]。有研究发现,行颈椎后路手术患者术前 T1 slope 越大,术后 C2-C7 前凸角度减小程度越明显^[8,11,12]。但也有研究发现,颈椎 ACDF 术后,较大的术前 T1 slope 往往预示着术后更大的 C2-C7 前凸角度^[9,13]。在脊柱侧凸畸形矫形涉及胸椎,导致术后 T1 slope 发生改变时,增大的 T1 slope 也需要更大的颈椎前凸曲度与之匹配^[10]。我们考虑,T1 slope 对颈椎前路与后路手术术后曲度变化的不同,可能与颈椎后路术后,颈椎因固定或肌肉功能减弱导致代偿能力减弱有关。在我们的研究中,发现术前较大 C7 slope 预示着术后较大的 C2-C7 前凸曲度,并进

表 2 退变性颈椎节段后凸组与颈椎前凸组的术前、术后 1 年临床功能评分

Table 2 Comparison of clinical outcomes between preoperative and postoperative 1-year visit in both groups

	退变性颈椎节段后凸组 Degenerative cervical focal kyphosis group			颈椎前凸组 Cervical lordosis group		
	VAS评分(分) VAS score	颈椎功能 障碍指数(%) NDI	JOA评分(分) JOA score	VAS评分(分) VAS score	颈椎功能 障碍指数(%) NDI	JOA评分(分) JOA score
术前 Preoperation	3.6±1.9	24.6±11.1	14.0±2.1	3.5±2.2	20.7±12.3	15.0±1.7
术后 1 年 1-year visit postoperation	1.6±1.0 ^①	7.6±5.4 ^①	15.5±1.3 ^①	1.3±1.1 ^①	7.1±5.2 ^①	16.3±0.9 ^①

注:①与术前相比, $P<0.05$

Note: ①Compared with preoperative score, $P<0.05$

一步发现术前 C7 slope 对术后融合节段角度也有预测作用,术前较大的 C7 slope 更利于术后融合节段前凸角度的维持。

T1 slope 与颈椎曲度的差值 (T1 slope-CL) 被证实与 C2-C7 SVA 相关,并且与生活质量相关^[8]。有学者依据数学算法,将 T1 slope 或 C7 slope 与颈椎曲度的差值简化为 C2 slope,发现同

样能够较好反映生活质量^[16]。也有研究与之结论相反,认为 C2 slope 与临床功能并不相关^[17-19]。本研究发现,在退变性颈椎节段后凸组患者中 C2 slope 与临床功能相关,而在颈椎前凸组患者中二者则无明显相关。提示既往研究结果的不一致可能与入组人群不同有关,只有在颈椎矢状位力线异常的患者中,C2 slope 的改变才更有临床意义。

表 3 退变性颈椎节段后凸组及颈椎前凸组术前 C2 倾斜角、C7 倾斜角与术前、术后 1 年影像学参数和术前临床功能评分的相关系数

Table 3 Correlation coefficient between preoperative C2 slope and C7 slope and preoperative and postoperative 1-year visit imaging parameters and preoperative clinical outcomes in both groups

	退变性颈椎节段后凸组 Degenerative cervical focal kyphosis group		颈椎前凸组 Cervical lordosis group	
	术前 C2 倾斜角 Preoperative C2 slope	术前 C7 倾斜角 Preoperative C7 slope	术前 C2 倾斜角 Preoperative C2 slope	术前 C7 倾斜角 Preoperative C7 slope
术前 C2-C7 曲度 Preoperative C2-C7 curve	0.647 ^①	-0.598 ^①	0.505 ^①	-0.559 ^①
术前 C2-C7 矢状位垂直轴 Preoperative C2-C7 SVA	-0.070	0.595 ^①	0.784 ^①	0.509 ^①
术前 VAS 评分 Preoperative VAS score	0.122	0.119	-0.094	0.055
术前颈椎功能障碍指数 Preoperative NDI	0.433 ^①	0.192	0.063	0.219
术前 JOA 评分 Preoperative JOA score	-0.066	-0.025	-0.064	-0.015
术后 1 年 C2-C7 曲度 Postoperative 1-year visit C2-C7 curve	0.021	-0.446 ^①	0.120	-0.240 ^①
术后 1 年 C2-C7 矢状位垂直轴 Postoperative 1-year visit C2-C7 SVA	-0.105	0.367 ^①	0.125	-0.013
术后 1 年融合节段角度 Postoperative 1-year visit focal angle of fused levels	0.088	-0.617 ^①	0.030	-0.127

注:① $P<0.05$

Note: ① $P<0.05$

表 4 术后 1 年临床功能评分与影像学参数的相关系数

Table 4 Correlation coefficient between postoperative 1-year visit clinical outcomes and postoperative 1-year visit imaging parameters

	VAS评分 VAS score		颈椎功能障碍指数 NDI		JOA评分 JOA score	
	退变性颈椎节段后凸组 Degenerative cervical focal kyphosis group	颈椎前凸组 Cervical lordosis group	退变性颈椎节段后凸组 Degenerative cervical focal kyphosis group	颈椎前凸组 Cervical lordosis group	退变性颈椎节段后凸组 Degenerative cervical focal kyphosis group	颈椎前凸组 Cervical lordosis group
C2-C7 曲度 C2-C7 curve	0.040	0.221	0.206	-0.103	-0.205	-0.165
融合节段角度 Focal angle of fused levels	0.053	0.190	0.146	-0.007	-0.147	0.033
C2-C7 矢状位垂直轴 C2-C7 SVA	0.299 ^①	0.176	0.234 ^①	0.081	0.112	0.221
C2 倾斜角 C2 slope	0.065	0.235	0.334 ^①	-0.117	-0.099	0.045
C7 倾斜角 C7 slope	-0.023	-0.221	-0.172	0.109	0.153	0.196

注:① $P<0.05$

Note: ① $P<0.05$

另外,我们发现 C2 slope 主要与 NDI 相关,与反映脊髓功能的 JOA 颈椎病评分相关性不明显。

对于测量可能存在误差,本研究所需参数均由两名脊柱外科医生间隔 2 周分 2 次进行测量,并对其组间和组内一致性进行分析,结果显示测量者具有很好的组内一致性和组间一致性。对于入组患者手术节段和内固定方式存在的差异,在选择颈椎前凸对照组患者时,使用倾向性评分对匹配因素进行控制,尽量减少混杂因素的影响,将来设计更为完善的前瞻性研究可得出更高级别的证据。

综上所述,在退变性颈椎节段后凸患者中,C2 slope 与临床功能相关;C7 slope 与临床功能不直接相关,但与颈椎矢状位力线相关,并对术后颈椎整体曲度及融合节段角度有一定预测作用。这种相互关系在颈椎前凸患者中并不显著,提示 C2 slope 及 C7 slope 对颈椎矢状位力线及临床功能的评估价值在颈椎曲度异常的情况下更有意义。

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全切除, 辅以后方长节段固定的方式进行神经减压及畸形矫正, 术中需警惕神经系统并发症的发生。

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