临床论著

C3-7 单开门椎管扩大成形术后颈椎矢状位序列的变化及其与颈椎功能的相关性

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【摘要】目的:探究颈椎单开门椎管扩大成形术后全颈椎矢状位序列的变化,探讨颈椎矢状位序列变化的意义及其与患者颈椎功能状态的关系。**方法:**回顾性分析我院 2015 年 1 月~2018 年 7 月收治的脊髓型颈椎病患者164例,其中男性 95 例,女性 69 例,年龄 64.8±18.3(48~86)岁。随访时间 22.7±11.3(9~46)个月。所有患者均行 C3-7 后路单开门椎管扩大成形术。在患者术前和末次随访的颈椎侧位 X 线片上测量颈椎矢状位序列参数:C1-2 Cobb 角、C2-7 Cobb 角、颈椎弧弦距(cervical arc chord distance,CACD)、颈倾角(cervical tilting,CERT)、颅倾角(cranial tilting,CRAT)、颈总角(cervical global alignment,CGA)、T1 倾斜角(thoracic 1 slope,T1S),C7 倾斜角(C7 slope,C7S)和 C2-7 矢状垂线轴(C2-7 sagittal vertical axis,SVA)。记录入组患者术前及末次随访时颈痛视觉模拟评分(visual analog scale,VAS)及改良日本骨科协会评分(modified Japanese Orthopaedic Association,mJOA)评分,采用配对样本 t 检验比较手术前后各参数的变化,Pearson 相关性分析颈椎矢状位序列参数变化之间的相关性及与颈椎功能状态评分(颈痛 VAS、mJOA 评分)的相关性。**结果:**颈椎单开门椎管扩大成形术后 T1S 较术前减小 1.25°±3.34°(21.38°±7.54° vs 20.13°±7.16°,P=0.004),C7S 较术前减小 0.44°±4.23°(28.05°±7.72° vs 27.61°±7.81°,P=0.012),C2-7 Cobb 角较术前减小 5.51°±6.88°(15.92°±12.57° vs 10.40°±10.93°,P<0.001),CACD 较术前减小 1.50±3.92mm(6.94±5.69mm vs 5.44±5.52mm,P=0.003),CERT 较术前减小 2.23°±5.27°(13.45°±6.37° vs 11.22°±6.78°,P=0.001),C2-7 SVA 较术前增大 3.35±9.90mm(18.20±9.05mm vs 21.55±10.65mm,P=0.009),C1-2 Cobb 角较术前增大 2.06°±5.09°(39.56°±0.46° vs 41.62°±0.70°,P=0.002)。末次随访 VAS(1.52±1.47 分)显著高于术前(1.02±1.12 分,P=0.007)。Pearson 相关性分析显示 C2-7 SVA、CACD、CGA、C2-7 Cobb 角、C1-2 Cobb 角、CERT、CRAT 的变化相互之间有显著统计相关性(P<0.05)。手术前后 VAS 的变化与 C2-7 SVA(r=0.462,P<0.001)、C1-2 Cobb 角(r=0.362,P<0.01)及 CRAT(r=0.323,P<0.01)的变化呈正相关,与 CGA(r=-0.316,P<0.01)及 CACD 变化(r=-0.344,P<0.01)呈负相关,mJOA 评分手术前后的变化与 C2-7 SVA(r=0.273,P<0.05)及 C1-2 Cobb 角(r=0.298,P<0.05)的变化呈正相关。**结论:**C3-7 单开门椎管扩大成形术后出现下颈椎生理曲度变直,头部重心位置前移,上颈椎及颈胸段脊柱过伸。C3-7 单开门椎管扩大成形术后轴性症状加重与颈椎矢状位序列的变化有关。

【关键词】单开门椎管扩大成形术;颈椎矢状位序列;颈椎功能;相关性分析

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Sagittal alignment changes of cervical spine in patients with cervical spondylotic myelopathy after cervical 3-7 single-door laminoplasty and its correlation with functional status of cervical spine/YANG Peng, WEN Bingtao, GE Rile, et al//Chinese Journal of Spine and Spinal Cord, 2020, 30(2): 123-129

【Abstract】 Objectives: To investigate the changes of sagittal alignment of the cervical spine after C3-7 single-door laminoplasty, and to explore its relationship with the functional status of cervical spine after laminoplasty. **Methods:** Retrospectively reviewed data of 164 patients between January 2015 and July 2018. There were 95 males and 69 females with an average age of 64.8±18.3(48-86) years. Follow up time: 22.7±11.3(9-46) months. Inclusion criteria: patients diagnosed of cervical spondylotic myelopathy. Exclusion criteria:

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previous history of spinal surgery, history of tumors, history of cervical trauma, sagittal spinal imbalance, scoliosis, spine infection. The C2-7 sagittal vertical axis(C2-7 SVA), cervical 1-2 Cobb angle, cervical 2-7 Cobb angle, cervical arc chord sistance (CACD), cervical tilting (CERT), cranial inclination (Cranial Tilting, CRAT), cervical global alignment(CGA), thoracic 1 slope(T1S) and cervical 7 slope(C7S) were measured and recorded using PACs 3.0 system. The neck pain visual analog scale(VAS) and modified Japanese Orthopaedic Association (mJOA) score before operation and at final follow-up were recorded. All data were analyzed by SPSS 24.0 software. **Results:** Compared with preoperative, T1S decreased by 1.25±3.34(21.38°±7.54° vs 20.13° ±7.16°, P=0.004), C7S decreased by 0.44°±4.23°(28.05°±7.72° vs 27.61°±7.81°, P=0.012), C2-7 Cobb angle decreased by 5.51°±6.88°(15.92°±12.57° vs 10.40°±10.93°, P<0.001), CACD decreased by 1.50±3.92mm(6.94± 5.69mm vs 5.44±5.52mm, P=0.003), CERT decreased by 2.23°±5.27°(13.45°±6.37° vs 11.22°±6.78°, P=0.001), C2-7 SVA increased by 3.35±9.90mm (18.20±9.05mm vs 21.55±10.65mm, P=0.009), C1-2 Cobb angle increased by 2.06°±5.09°(39.56°±0.46° vs 41.62°±0.70°, P=0.002), VAS (1.52±1.47) at final follow-up was significantly higher than that before operation (1.02±1.12)(P=0.007). Pearson correlation analysis showed that the changes of C2-7 SVA, CACD, CGA, C2-7 Cobb angle, C1-2 Cobb angle, CERT and CRAT were significantly correlated with each other(P<0.05). The difference of VAS before and after surgery were positively correlated with the difference of C2-7 SVA(r=0.462, P<0.001), C1-2 Cobb angle(r=0.362, P<0.01) and CRAT (r=0.323, P<0.01), and negatively correlated with the difference of CGA (r=-0.316, P<0.01) and CACD (r=-0.344, P<0.01). The changes of mJOA score before and after operation were positively correlated with the changes of C2-7 SVA(r=0.273, P<0.05) and C1-2 Cobb angle(r=0.298, P<0.05). **Conclusions:** The sagittal alignment of cervical spine in patients with cervical spondylotic myelopathy changed significantly after C3-7 single-door laminoplasty, including kyphotic changes of the lower cervical spine, forward tilting of gravity center of cervical spine, and overextension of the upper cervical spine and cervicothoracic spine. These changes were not only due to the influence of the cervical posterior structuraldamage, but also the compensatory mechanism. The deterioration of axial symptoms after cervical laminoplasty is related to the change of sagittal alignment of cervical spine.

【Key words】 Cervical spondylotic myelopathy; Sagittal parameters of cervical spine; Laminoplasty; visual analog scale; modified Japanese Orthopaedic Association

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近年来，颈椎矢状位序列的研究受到了广泛的关注，许多研究者报道颈椎矢状位序列对颈椎手术治疗效果有很大影响[1~3]。根据以往研究[4,5]，我们将颈椎矢状位序列的测量分为三大部分：(1)颈椎前凸曲度测量，包括 C1-2 Cobb 角、C2-7 Cobb 角、颈椎弧弦距（cervical arc chord distance,CACD）和颈总角（cervical global alignment,CGA）；(2)头颈部重心位置测量，包括颅倾角(cranial tilting,CRAT)、颈倾角(cervical tilting,CERT)、C2-7 矢状垂线轴（C2-7 sagittal vertical axis,C2-7 SVA）；(3)颈椎基底部斜率，也称颈胸段交界区角度，包括 C7 倾斜角(C7 slope,C7S)、T1 倾斜角(T1 slope,T1S)。

脊髓型颈椎病患者常有多节段椎管狭窄，椎间盘退变程度重，同时多伴有颈部肌肉劳损，这些因素使颈椎的平衡更加不稳定。C3-7 单开门椎管扩大成形术是治疗脊髓型颈椎病的常规手术方法，以往的研究表明，椎板成形术后可能会发生下颈椎曲度变直甚至是后凸性改变[6,7]。但目前尚不清楚椎板成形术后全颈椎矢状位序列的详细变化及其与颈椎功能状态变化的关联性。本研究纳入了 9 项颈椎矢状位序列的参数并进行了详细分析，为颈椎矢状面序列研究提供有价值的临床资料。本研究涉及的所有病例均来源于北京大学国际医院。

1 资料与方法

1.1 一般资料

本研究共纳入 164 例患者，男性 95 例，女性 69 例，年龄 64.8±18.3(48~86)岁，所有患者术前诊断均为脊髓型颈椎病，入组患者手术方式均为 C3-7 单开门椎管扩大成形术。随访时间 22.7±

11.3 个月(9~46 个月)。

纳入标准:(1)确诊为脊髓型颈椎病;(2)接受 C3-7 后路单开门椎管扩大成形术治疗。排除标准:(1)既往脊柱手术史;(2)肿瘤病史;(3)颈椎外伤史;(4)全脊柱矢状位失衡;(5)脊柱侧凸;(6)脊柱感染性疾病。

所有患者均术中均采用 CENTERPIECE 微型钛板(Medtronic Sofamor Danek USA Inc.)内固定。2 例患者分别术后 1d、3d 出现了 C5 神经根麻痹,均经保守治疗后于半年内恢复。

1.2 手术方法

患者全麻后取俯卧位, 以 Mayfield 头架固定头部,手术台头侧抬高 30°,适当屈曲颈椎。C 型臂 X 线机定位后取 C3-7 后正中纵向切口, 分离并以自动拉钩牵开两侧椎旁肌,显露 C3-7 棘突、椎板以及双侧侧块,右侧剥离至椎板与侧块交界处,左侧剥离达侧块纵轴中线外侧 1~2mm。所有患者采用椎板右侧开槽,保留右侧椎板内层皮质,然后自左侧切断全层椎板,切断 C2/3、C7/T1 棘突间韧带及黄韧带,自左向右推开棘突和椎板,松解椎板和硬膜囊和脊髓间的粘连,完成单开门。于左侧椎板断端间安装合适大小钛金属板,以螺钉固定。C 型臂 X 线机确定内固定位置良好, 逐层缝合切口,留置皮下引流,术毕。

1.3 数据测量

使用 PACs 3.0 系统 (Picture Archiving and Communication Systems 3.0,GE,USA) 在每例患者术前和末次随访的颈椎侧位 X 线片上测量颈椎矢状位序列的参数,包括:C1-2 Cobb 角、C2-7 SVA、C2-7 Cobb 角、CACD、CGA、CERT、CRAT、C7S、T1S。测量并记录术前和术后末次随访的改良日本骨科协会评分 (modified Japanese Orthopaedic Association,mJOA) 评分和颈痛视觉模拟评分(visual analog scale,VAS)评分。

矢状位序列的参数测量由两位合著者按上述方法分别测量 2 次,取平均值作为最终测量数据。具体测量方法见图 1。

1.4 统计学分析

使用 SPSS 24.0 软件进行统计分析。采用配对样本 t 检验比较手术前后颈椎矢状位序列的参数及颈椎功能评分的变化。$P<0.05$ 认为差异具备统计学意义。用 Pearson 相关系数(r)评价手术前后各指标变化的关联性,0.0~0.2 为无相关,0.2~0.4 为弱相关,0.4~0.6 为中等程度相关,0.6~0.8 为强相关。

2 结果

2.1 颈椎矢状位序列参数及颈椎功能评分变化

末次随访时 T1S、C7S、C2-7 Cobb 角、CACD、CGA 和 CERT 较术前显著降低 ($P<0.05$)。而 C2-7 SVA 和 C1-2 Cobb 角显著升高($P<0.05$)。术后 CRAT 无统计学差异 ($P>0.05$) 末次随访时 VAS 及 mJOA 较术前显著升高($P<0.05$)(表 1,图 2)。

2.2 颈椎矢状位序列参数变化之间的相关性

Pearson 分析显示, 术前和术后末次随访时 C2-7 SVA 差值与 CRAT 差值呈强正相关 ($r=0.679$,$P<0.01$),与 C1-2 Cobb 角差值呈中度正相关 ($r=0.555$,$P<0.01$), 与 C2-7 Cobb 角差值 ($r=-0.491$,$P<0.01$),CERT 差值 ($r=-0.545$,$P<0.01$),CGA 差值($r=-0.593$,$P<0.01$)和 CACD 差值($r=-0.558$,$P<0.01$)呈中度负相关。C2-7 Cobb 角差值与 CGA 差值($r=0.702$,$P<0.01$)及 CACD 差值呈强正相关($r=0.739$,$P<0.01$),与 CRAT 差值呈中度负相关($r=-0.425$,$P<0.01$)。T1S 差值与 C7S 差值呈弱正相关($r=0.321$,$P<0.01$),但 T1S 及 C7S 手术前后的变化与其他颈椎矢状位序列参数没有统计学关联性(表 2)。

2.3 颈椎矢状位序列参数与颈椎功能的相关性

术前及末次随访时颈痛 VAS 评分差值与 C2-7 SVA 差值($r=0.462$,$P<0.001$)中度正相关,C1-2 Cobb 角差值($r=0.362$,$P<0.001$)弱正相关。mJOA 差值与 C2-7 SVA 差值 ($r=0.273$,$P=0.029$)及 C1-2 Cobb 角差值($r=0.298$,$P=0.017$)呈弱正相关(表 3)。

3 讨论

近年来关于颈椎矢状位的研究越来越多,许多研究者认为其与脊柱的整体平衡之间有着重要关系[8,9]。颈椎矢状位序列是指自然站立时维持头颈部重心正常位置的合理序列,受年龄、颈部肌肉状态、椎体形态、小关节退变、椎间盘弹性等众多因素的影响[10-12]。

C3-7 单开门椎管扩大成形术是治疗脊髓型颈椎病的常用手术方式。脊髓型颈椎病往往存在多节段的椎间盘及小关节退变, 而且存在不同程

度的颈椎椎旁肌萎缩，这些因素加重了颈椎矢状位力线的不稳定。许多研究报道椎板成形术后C2-7 曲度后凸性改变[13,14],但也有作者的研究指出颈椎后路手术并没有对下颈椎曲度造成影响,北京大学第三医院 Lin 等[15]回顾性分析了 96 例单开门椎管扩大成形术患者的资料，发现颈椎椎板成形术后患者的 C2-7 Cobb 角与术前相比无显著差异,但 C0-2 Cobb 角及 C2-7 SVA 显著增大，表明颈椎单开门椎管扩大成形术后下颈椎曲度无明显变化，但出现了颈椎矢状位序列向前失衡的趋势，而上颈椎的过伸是矢状位序列的代偿机制。

目前对于颈椎后路手术对颈椎矢状位序列的影响广受关注，许多研究者甚至认为矢状位序列可以作为颈椎后路手术效果的预测因素，但绝大多数研究者们仅截取了颈椎矢状位的部分参数作

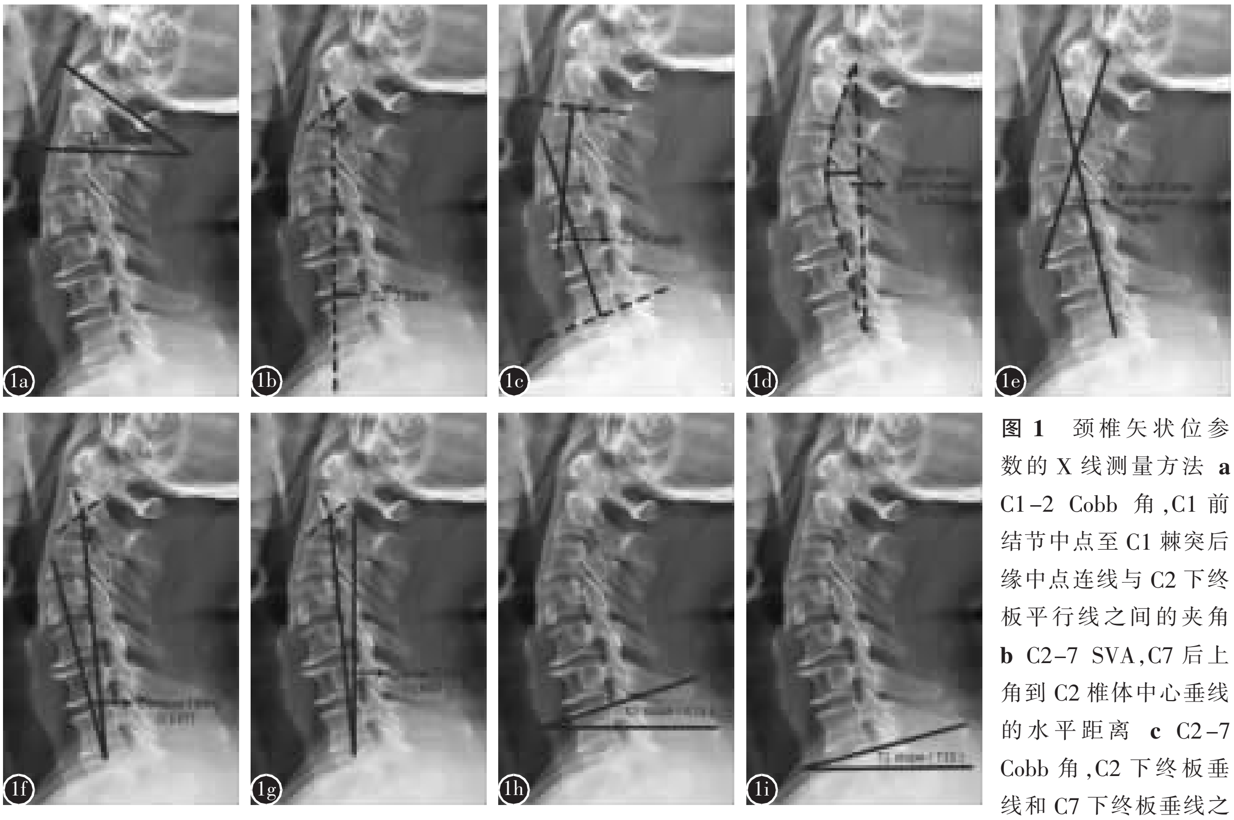

图 1　颈椎矢状位参数的 X 线测量方法 **a** C1-2 Cobb 角,C1 前结节中点至 C1 棘突后缘中点连线与 C2 下终板平行线之间的夹角 **b** C2-7 SVA,C7 后上角到 C2 椎体中心垂线的水平距离 **c** C2-7 Cobb 角,C2 下终板垂线和 C7 下终板垂线之间的夹角 **d** CACD,以齿状突和 C7 后下角连线为一条线,以各颈椎后表面为一条线,测量两条线之间的最大垂直距离 **e** CGA,C2 和 C7 后表面平行线之间的夹角 **f** CERT,T1 上终板中心至 C2 椎体中心连线与 T1 上终板中心垂线之间的夹角 **g** CRAT,T1 椎体上终板中点到 C2 椎体中心的连线和铅垂线之间形成的角度 **h** C7S,C7 上终板平行线与水平线之间的夹角 **i** T1S,T1 上终板平行线与水平线之间的夹角

Figure 1　Measurement of sagittal parameters of the cervical spine on X-Ray **a** C1-2 angle, the angle formed by the line from the midpoint of C1 anterior nodule to the midpoint of posterior edge of C1 spinous process and the parallel line to the C2 inferior endplate **b** C2-7 SVA, the horizontal distance between the posterosuperior corner of C7 the plumb line from the center of the C2 vertebra **c** C2-7 angle, the Cobb angle between the inferior endplates of C2 and C7 **d** CACD, the maximum distance between the line connecting the posterosuperior corner of the dens and the posteroinferior corner of C7 and the posterior surface of each cervical vertebra **e** CGA, the angle formed by the parallel lines of the posterior surface of C2 and C7 **f** CERT, the angle formed by the plumb line from the center of the superior endplate of T1(T1SEP) and the line from the center of T1 SEP to the center of C2 vertebra **g** CRAT, the angle formed by the line from T1SEP to the center of C2 vertebra and the plumb line from C2 vertebra **h** C7S, the angle between the horizontal and the parallel line of the superior endplate of C7(C7SEP) **i** T1S, the angle between the horizontal and the parallel line of the superior endplate of T1(T1SEP)

为研究对象，并且对于参数变化的意义表述不够清晰。为详细分析C3-7单开门椎管扩大成形术对全颈椎序列的影响，本研究纳入了9项颈椎矢状位序列的参数，其中C1-2 Cobb角代表上颈椎曲度，C2-7 Cobb角、CACD、CGA代表下颈椎曲度，C2-7 SVA、CERT、CRAT代表头颈部重心位置，T1S、C7S代表颈胸段交界处曲度。

表1 术前与末次随访时矢状位序列参数及颈椎功能评分

Table 1 Sagittal parameters and cervical functional score before and after surgery

	术前 Preoperative	末次随访 Final follow-up	差值 Difference	*P*值 *P* value
C2-7 SVA(mm)	18.20±9.05	21.55±10.65	3.35±9.90	0.009
C1-2 Cobb角(°) C1-2 Cobb angle	39.56±0.46	41.62±0.70	2.06±5.09	0.002
C2-7 Cobb角(°) C2-7 Cobb angle	15.92±12.57	10.40±10.93	-5.51±6.88	<0.001
CGA(°)	12.75±11.11	11.48±9.99	-1.27±6.58	0.029
CACD(mm)	6.94±5.69	5.44±5.52	-1.50±3.92	0.003
CERT(°)	13.45±6.37	11.22±6.78	-2.23±5.27	0.001
CRAT(°)	8.39±5.15	9.55±6.34	1.16±5.70	0.11
T1S(°)	21.38±7.54	20.13±7.16	-1.25±3.34	0.004
C7S(°)	28.05±7.72	27.61±7.81	-0.44±4.23	0.012
mJOA(分) mJOA(score)	10.94±2.44	13.78±2.55	2.84±2.01	<0.001
颈痛VAS(分) Neck pain VAS	1.02±1.12	1.52±1.47	0.50±1.45	0.007

注：SVA，矢状垂线轴；CGA，颈总角；CACD，弧弦距；CERT，颈倾角；CRAT，颅倾角；T1S，胸1倾斜角；C7S，C7倾斜角

Note: SVA, sagittal vertical axis; CGA, cervical global alignment; CACD, cervical arc chord distance; CERT, cervical tilting; CRAT, cranial tilting; T1S, thoracic 1 slope; C7S, cervical 7 slope

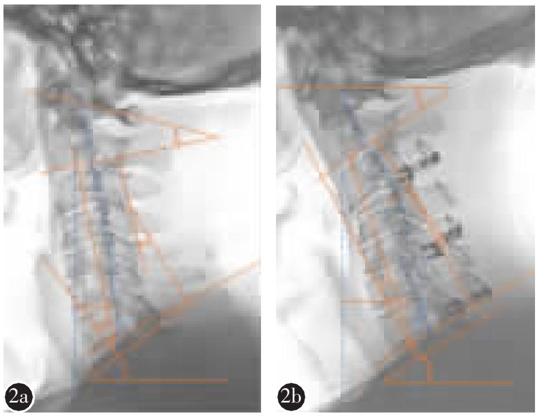

图2 男性，68岁，C3-7单开门椎管扩大成形术术前与术后13个月X线片颈椎矢状位序列的参数变化 **a、b** C1-2 Cobb角增大，T1S减小，提示上颈椎及颈胸段脊柱过伸；C2-7 Cobb角减小，可见下颈椎生理曲度变直；C2-7 SVA增大，CERT减小，可见头部重心位置前移

Figure 2 Changes in cervical saggital alignment after C3-7 single-open-door laminoplasty on X-Ray of a 68 year old male **a, b** The increase of C1-2 Cobb angle and T1S indicating the hyperextension of upper cervical spine and cervical thoracic spine; the decrease of C2-7 Cobb angle indicating the straightening of the lower cervical curvature, the increase of C2-7 SVA and CERT indicating the forward movement of the head gravity center

表2 手术前后各矢状位序列参数变化的Pearson相关性

Table 2 Pearson correlation among changes in sagittal parameters before and after surgery

	C2-7 SVA	C1-2 Cobb角(°) C1-2 Cobb angle	C2-7 Cobb角(°) C2-7 Cobb angle	CERT	CRAT	CGA	CACD	T1S	C7S
C2-7 SVA	/	0.555①	-0.491①	-0.545①	0.679①	-0.593①	-0.558①	0.343①	0.131
C1-2 Cobb角(°) C1-2 Cobb angle	0.555①	/	-0.164	-0.269①	0.416①	-0.195	-0.242	0.164	0.11
C2-7 Cobb角(°) C2-7 Cobb angle	-0.491①	-0.164	/	0.388①	-0.425①	0.702①	0.739①	-0.013	0.044
CERT	-0.545①	-0.269①	0.388①	/	-0.825①	0.495①	0.439①	0.006	-0.023
CRAT	0.679①	0.416①	-0.425①	-0.825①	/	-0.503	-0.524①	0.159	0.253①
CGA	-0.593①	-0.195	0.702①	0.495①	-0.503①	/	0.734①	-0.008	0.066
CACD	-0.558①	-0.242	0.739①	0.439①	-0.524①	0.734①	/	-0.007	0.057
T1S	0.243	0.164	-0.013	0.006	0.159	-0.008	-0.007	/	0.321①
C7S	0.131	0.11	0.044	-0.023	0.253①	0.066	0.057	0.321①	/

注：SVA，矢状垂线轴；CGA，颈总角；CACD，弧弦距；CERT，颈倾角；CRAT，颅倾角；T1S，T1倾斜角；C7S，C7倾斜角；①$P<0.05$

Note: SVA, sagittal vertical axis; CGA, cervical global alignment; CACD, cervical arc chord distance; CERT, cervical tilting; CRAT, cranial tilting; T1S, thoracic 1 slope; C7S, cervical 7 slope; ①$P<0.05$

表 3 手术前后矢状位序列参数变化与 VAS/mJOA 变化的 Pearson 相关性

Table 3 Pearson correlation among changes in sagittal parameters and VAS/mJOA before and after surgery

		C2-7 SVA	C1-2 Cobb 角(°) C1-2 Cobb angle	C2-7 Cobb 角(°) C2-7 Cobb angle	CERT	CRAT	CGA	CACD	T1S	C7S
VAS	*r*	0.462	0.362	-0.186	-0.147	0.323	-0.316	-0.344	0.016	0.228
	P	<0.001	0.003	0.142	0.247	0.009	0.011	0.005	0.898	0.07
mJOA	*r*	0.273	0.298	-0.14	-0.165	0.213	-0.127	-0.243	0.004	-0.003
	P	0.029	0.017	0.271	0.193	0.091	0.316	0.053	0.978	0.984

注:SVA,矢状垂线轴;CGA,颈总角;CACD,弧弦距;CERT,颈倾角;CRAT,颅倾角;T1S,T1 倾斜角;C7S,C7 倾斜角

Note: SVA, sagittal vertical axis; CGA, cervical global alignment; CACD, cervical arc chord distance; CERT, cervical tilting; CRAT, cranial tilting; T1S, thoracic 1 slope; C7S, cervical 7 slope

本研究显示,椎板成形术后 C1-2 Cobb 角增加,提示存在术后上颈椎过伸;代表下颈椎曲度相关参数(C2-7 Cobb 角、CGA、CACD)均显著降低,这提示 C3-7 单开门椎管扩大成形术后出现了下颈椎曲度变直;而 C2-7 SVA、CERT 显著下降,提示术后颈椎重心前移,这与之前的研究一致[16];C7S 及 T1S 显著下降,提示颈胸段脊柱过伸。这些参数的变化提示 C3-7 单开门椎管扩大成形术后颈椎矢状位序列发生重组,其中既有矢状位失平衡的表现,也包含了颈椎的代偿机制。其中,下颈椎曲度变直及颈椎重心的前移使得颈椎整体序列恶化,而上颈椎过伸维持了患者正常的视线,颈胸段交界处过伸改善了头颈部重心的前移幅度,由此我们认为 C1-2 Cobb 角及 C7S 及 T1S 改变属于代偿性改变。但值得注意的是,颈胸段脊柱的代偿性改变同时也提示颈椎椎板成形术可能会对整个脊柱的矢状面序列产生影响。

以往研究报道,C2-7 SVA 与 C2-7 Cobb 角及 T1S 有显著相关性[17,18]。本研究结果显示术前和术后头颈部重心相关参数(C2-7 SVA、CERT、CRAT)的变化与颈椎曲度相关参数(C1-2 Cobb 角、C2-7 Cobb 角、CACD、CGA)的变化存在显著相关性,其中,C2-7 SVA 的变化与除 C7S 以外的所有矢状位序列的参数变化均存在显著关联性,这提示颈椎单开门椎管扩大成形术后颈椎作为一个整体发生矢状位序列重组,其中 C2-7 SVA 的增大与术后颈椎矢状位序列的恶化及代偿机制均存在显著关联性,由此我们认为颈椎单开门椎管扩大成形术后 C2-7 SVA 增大是颈椎矢状位序列整体性变动的启动因素。

一些研究报道颈椎手术后颈椎矢状位序列变化与颈椎功能变化呈正相关或负相关[16,19],但仍没有定论。Kato 等[20]的研究指出 C2-7 SVA 与颈椎椎板成形术后健康相关生命质量评分(health related quality of life,HRQOL)和轴性颈痛存在相关性;Tang 等[18]发现术前 C2-7 SVA 超过 40mm 的患者术后颈椎功能状态更差。我们的研究显示 C3-7 单开门椎管扩大成形术后颈椎 mJOA 及 VAS 评分均升高,证明术后患者神经功能改善,但出现了颈椎轴向疼痛症状加重。Pearson 分析显示 VAS 评分变化与术后 C2-7 SVA、CRAT、C1-2 Cobb 角变化呈正相关,而与下颈椎曲度相关参数及颈胸段交界处相关参数的变化无显著相关性。由此可以的得出椎板成形术后轴向症状加重与颈椎重心位置前移及上颈椎过伸相关。

同时,我们的数据显示手术前后 mJOA 变化与 C2-7 SVA 及 C1-2 Cobb 角的变化之间存在正相关,虽然相关性较弱,但这提示颈椎矢状位序列的改善可能对颈脊髓功能的恢复有着促进作用。对于这一点,我们认为矢状位变化过程中脊髓生存空间的同样发生了变化,而这需要通过进一步研究探讨。

然而,本研究也存在一些局限性。首先,相对较小的样本量限制了按照脊髓压迫程度进行分组;第二,本研究未统计分析颈椎肌肉对矢状位序列的参数的影响;第三,本研究仅分析了 C3~7 单开门成形术后颈椎矢状位的变化,未统计其他类型的颈椎后路手术。

4 小结

脊髓型颈椎病患者行 C3-7 单开门椎管扩大成形术后全颈椎矢状位序列重组,主要表现为下颈椎曲度(C2-7 Cobb 角、CGA、CACD)变直,头颈部重心位置前移(C2-7 SVA、CERT 增大),通过上颈椎及颈胸段脊柱过伸(C1-2 Cobb 角及 C7S, T1S 增大)对这些变化进行代偿,其中 C2-7 SVA 的增大在推动颈椎矢状位序列的整体性变化中有重要作用。C3-7 单开门椎管扩大成形术后轴性症状加重与颈椎重心前移(C2-7 SVA 增加)和上颈椎过伸(C1-2 Cobb 角增大)有关,而颈椎重心位置前移与上颈椎过伸可能对颈脊髓功能的恢复有促进作用。

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