

临床论著

颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术后早期颈椎矢状面平衡的变化

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【摘要】 目的:探讨颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术治疗多节段脊髓型颈椎病(cervical spondylotic myelopathy, CSM)的早期临床疗效。**方法:**回顾性分析 2013 年 8 月~2020 年 9 月我院采用颈后路椎管扩大椎板成形术治疗的 75 例多节段 CSM 患者,其中 42 例患者采用颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术(升顶组),年龄 31~79 岁(57.2 ± 10.7 岁);33 例患者采用传统“关节囊悬吊法”单开门椎管扩大椎板成形术(悬吊法组),年龄 48~82 岁(67.2 ± 9.6 岁)。所有患者于术后 3~14 个月门诊随访。收集两组患者的住院相关基本信息;在术前和末次随访时的颈椎 X 线片上测量颈椎矢状面平衡参数,包括 C0-2 Cobb 角、C2-7 Cobb 角、C2-7 矢状面轴向距离(C2-7 SVA)、C7 倾斜角(C7-Slope),同时测量颈椎活动度(ROM);术前和末次随访时采用改良 JOA(mJOA)评分、VAS 评分和颈椎功能障碍指数(NDI)评估,计算 mJOA 评分改善率。**结果:**两组患者性别、术中出血量和平均随访时间差异无统计学意义($P > 0.05$)。升顶组患者年龄和术后住院天数均小于悬吊法组($P < 0.05$)。两组术前 C0-2 Cobb 角、C2-7 Cobb 角、C2-7 SVA、C7-Slope 和颈椎 ROM 均无统计学差异($P > 0.05$),末次随访时升顶组 C7-Slope 和 C2-7 SVA 小于悬吊法组($P < 0.05$),C2-7 ROM 大于悬吊法组($P < 0.05$)。两组末次随访时 mJOA 和 VAS 评分与术前比较均有明显改善,差异有统计学意义($P < 0.05$);两组间同时时间点 mJOA 和 VAS 评分比较无统计学差异($P > 0.05$),mJOA 评分改善率亦无统计学差异($P > 0.05$)。两组末次随访时 NDI 与术前比较无统计学差异($P > 0.05$),两组间同时时间点比较亦无统计学差异($P > 0.05$)。**结论:**与传统颈后路单开门椎管扩大椎板成形术相比,颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术治疗多节段 CSM 早期可获得相同神经功能改善效果,且在维持颈椎矢状面平衡及颈椎活动度方面更具优势。

【关键词】脊髓型颈椎病;颈后路椎管扩大椎板成形术;经肌间隙入路;升顶;矢状面平衡;颈椎活动度

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The preliminary changes of sagittal balance of cervical spine after posterior cervical intermuscular raising roof laminoplasty/ZHOU Shuai, ZHOU Feifei, ZHAO Yanbin, et al//Chinese Journal of Spine and Spinal Cord, 2021, 31(12): 1121-1128

【Abstract】 Objectives: To explore the preliminary clinical effects of multilevel cervical spondylotic myelopathy(CSM) by posterior cervical intermuscular raising roof laminoplasty. **Methods:** 75 patients with multilevel cervical spondylotic myelopathy underwent posterior cervical laminoplasty at our hospital between August 2013 and September 2020 were recruited in this retrospective study. Of all patients, 42 treated with posterior cervical intermuscular "raising roof" laminoplasty were included in the raising roof group (mean age, 57.2 ± 10.7 years; ranged 31 to 79 years), and 33 underwent posterior single open-door laminoplasty by traditional suture suspension fixation were included in the suture suspension group(mean age, 67.2 ± 9.6 years; range 48 to 82 years). All patients were followed up at 3-14 months after surgery at the outpatient department. The basic hospitalization information of the patients in the two groups were collected; Cervical sagittal balance parameters, including C0-2 Cobb angle, C2-7 Cobb angle, C2-7 sagittal vertical axis(C2-7 SVA), C7-Slope, and cervical range of motion (ROM) were measured on X-ray images before the operation and at the last follow-

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up. The modified JOA(mJOA) score, visual analogue scale(VAS) score and neck disability index(NDI) were evaluated before the operation and at the last follow-up, and the mJOA score recovery rate was calculated.

Results: There were no significant differences in terms of gender, intraoperative blood loss, and the mean follow-up time between the two groups ($P>0.05$). The age and postoperative hospital stay of patients in the raising roof group were smaller than those of the suture suspension group ($P<0.05$). There were no significant differences in preoperative C0-2 Cobb angle, C2-7 Cobb angle, C2-7 SVA, C7-Slope and cervical ROM($P>0.05$). C7-Slope and C2-C7 SVA of the raising roof group were smaller than those in suture suspension group at the last follow-up($P<0.05$), while C2-7 ROM in the raising roof group was better at the last follow-up($P<0.05$). The mJOA and VAS scores of both groups at the last follow-up were significantly improved than those before operation, and the differences were of statistical significance. There was no significant difference in mJOA and VAS scores between the two groups at the same time point ($P>0.05$), nor was there significant difference in mJOA score improvement rate ($P>0.05$). The NDI of both groups at the last follow up were not improved significantly than those before operation ($P>0.05$), also there was no statistical significance between the two groups at the same time point ($P>0.05$). **Conclusions:** Posterior cervical intermuscular raising roof laminoplasty can achieve the same neurological function improvement as the traditional posterior cervical single open-door laminoplasty in the early stage after operation in the treatment of multilevel CSM, and besides, it has more advantages in maintaining sagittal balance and cervical range of motion.

[Key words] Cervical spondylotic myelopathy; Posterior cervical laminoplasty; Intermuscular approach; Raising roof; Sagittal balance of cervical spine; Cervical range of motion

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脊髓型颈椎病(cervical spondylotic myelopathy, CSM)是一种常见的颈椎退行性疾病,是导致脊髓功能障碍的重要原因^[1]。对伴有严重神经功能障碍、保守治疗无效或临床症状进行性加重的患者需要尽早接受手术治疗。自 Hirabayashi 等^[2]报道颈椎后路单开门椎管扩大椎板成形术(posterior cervical open-door laminoplasty)以来,由于其在改善神经功能方面效果明确,已被脊柱外科医生广泛用于治疗多节段 CSM^[3]。但是,传统单开门椎管扩大椎板成形术在显露椎板时会对颈椎后方肌肉-韧带复合体造成破坏,术后常导致严重的颈部轴性症状、颈椎矢状面失平衡和颈椎活动度丢失等并发症,从而影响患者的预后。为减少手术显露对颈椎后方伸肌装置的破坏,2019 年起,我院开展了一种颈后路椎管扩大椎板成形术的改良术式,即颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术,经双侧肌间隙入路最大程度维持颈后伸肌装置的完整性,通过“升顶”方法扩大椎管容积、实现颈脊髓减压,同时使用金属 3D 打印人工假体支撑“升起”的椎板并通过 3D 打印假体与椎板的骨性融合实现即刻和远期的稳定性。本研究回顾性分析颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术患者术后颈椎活动度、神经功能改善及颈椎矢状面平衡相关测量指标,并与传

统“关节囊悬吊法”单开门椎管扩大椎板成形术比较,探讨本改良术式术后早期的临床疗效。

1 资料与方法

1.1 一般资料

病例纳入标准:(1)2013 年 6 月~2020 年 9 月在我院手术治疗的经临床症状、体征及影像学检查诊断为多节段 CSM 的患者;(2)行颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术或“关节囊悬吊法”单开门椎管扩大椎板成形术;(3)获得随访且术前、术后及随访影像学资料(颈椎 X 线片、CT 及 MRI)完整。

病例排除标准:(1)合并肌萎缩性脊髓侧索硬化症、脊髓肿瘤、急性脊髓损伤、继发性粘连性蛛网膜炎、多发性末梢神经炎等;(2)伴有颈椎前凸消失、严重后凸畸形、颈椎不稳者;(3)基础状况差,存在严重肝肾功能不全等疾病,不能耐受手术者;(4)伴有明显颈痛症状者。

依据纳入和排除标准,本研究共纳入 75 例患者,其中 42 例患者行颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术(升顶组),33 例患者行颈后路“关节囊悬吊法”单开门椎管扩大椎板成形术(悬吊法组)。两组患者的一般资料见表 1,两组性别和随访时间差异无统计学意义 ($P>0.05$),升

顶组患者手术年龄低于悬吊法组 ($P<0.05$)。入院后均行颈椎正侧位及过伸过屈位 X 线片、CT 和 MRI 检查。

1.2 手术方法

全身麻醉成功后,患者取俯卧位,Mayfield 头架颅骨牵引,维持颈椎正常中立位曲度或稍屈颈,上身抬高 $20^{\circ}\sim 30^{\circ}$ 。术前 30min 开始使用抗生素。

1.2.1 升顶组(以 C3~C6 节段为例) 常规消毒铺巾,沿中线于 C2~C7 棘突行后正中入切口,切开皮肤、皮下组织及项韧带,长约 10cm。在中线处切开深筋膜和斜方肌肌膜部分,在斜方肌筋膜深层向外侧分离,找到头半棘肌和颈半棘肌之间的间隙,钝性结合锐性分离至椎板表面。切断部分回旋肌和多裂肌,显露出 C3~C6 侧块和椎板外缘,用超声骨刀在右侧 C3~C6 椎板小关节内侧切除椎板的外层骨皮质,开槽作门轴;于左侧 C3~C6 椎板小关节内侧切断椎板的全层,并切开 C2/3 及 C6/7 间的黄韧带。将 C3~C6 椎板向右侧掀开,分别在左侧 C3、C4、C5、C6 椎板和侧块之间置入定制 3D 打印人工椎板,电钻钻孔并分别置入椎板和侧块固定螺钉,暂时不完全拧紧侧块螺钉。切断 C3-4-5-6 右侧门轴,将 C3~C6 椎板向左侧掀开,分别在右侧 C3、C4、C5、C6 椎板和侧块之间置入定制 3D 打印人工椎板,分别置入椎板和侧块固定螺钉,完全拧紧。再拧紧左侧全部侧块固定螺钉。分离粘连冲洗伤口,放置 2 根负压引流管,清点器械敷料无误后用 1 号可吸收线缝合头半棘肌和颈半棘肌肌膜之间的间隙,并间断缝合斜方肌筋膜及项韧带,2/0 号可吸收线缝合皮下组织,4/0 可吸收倒刺线皮内缝合皮肤。

1.2.2 悬吊法组(以左侧开门、右侧门轴为例)

常规消毒铺巾,取颈后正中 C2~T1 纵行直切口,切开皮肤、皮下及项韧带,止血。双侧棘突椎板骨膜下钝性剥离,干纱布填塞压迫止血,显露双侧 C3~C7 椎板,剪短 C6 和 C7 棘突末端过长部分。依次在 C3~C7 各棘突根部打孔,自 C3~C7 右侧小关节突内侧依次咬开椎板外板,并修成“V”形骨槽。再在 C3~C7 左侧小关节突内侧依次咬透椎板内、外板全层,咬开 C7/T1 及 C2/3 棘突间韧带及黄韧带左侧部分,以右侧骨槽为轴,自左向右掀开 C3~C7 椎板,并剪开各椎板附着的黄韧带,同时分开椎板与硬膜间的疏松粘连,见硬膜囊搏动良好。将 10 号粗丝线穿过各棘突尖部的孔缝于相应节段的关节囊拉紧打结。椎板开门处脊髓硬膜表面覆盖明胶海绵。伤口内置 1 根螺旋负压引流管,另行皮肤切口引出、固定。清点纱布器械无误后分层冲洗伤口,彻底止血,用可吸收缝线连续缝合项韧带、皮下,皮内缝合缝合皮肤。

1.3 术后处理

术后均常规使用抗生素 24h,根据引流情况于术后 24~48h 拔除引流管。嘱患者早期下床活动。升顶组术后不常规佩戴颈托,悬吊法组术后佩戴颈托制动时间不超过 2 周。结合患者及术中情况尽早开始颈部活动及肌肉锻炼。

1.4 观察指标

记录两组患者的手术时间、术中出血量、术后住院时间。所有病例于术后 3~14 个月进行门诊随访,进行临床疗效评价,并在颈椎 X 线片上进行影像学评估。

1.4.1 临床疗效评估 采用改良日本骨科协会(modified Japanese Orthopedic Association, mJOA)评分^[4]对患者术前和术后末次随访时神经功能进行评估,并计算其改善率,改善率(%)=(术后 mJOA 评分-术前 mJOA 评分)/(17-术前 mJOA 评分) $\times 100\%$;使用颈椎功能障碍指数(neck disability index, NDI)^[5]评价患者颈部疼痛对其功能以及生活质量的影响;疼痛视觉模拟量表(visual analogue scale, VAS)^[6]评分评价手术前后颈部疼痛症状。

1.4.2 影像学评估 在术前及随访时的颈椎 X 线片上,通过医学影像信息系统(Picture Archiving and Communication Systems, PACS)进行影像学测量。采用改良的 Cobb 法^[7]测量的 C2-7 Cobb 角评估颈椎曲度;McGregor 线法测量的 C0-2

表 1 两组患者术前一般资料的比较

Table 1 Comparison of basic information between the two groups

	升顶组(n=42) Group of raising roof	悬吊法组(n=33) Group of suture suspension
性别比(男/女) Sex ratio(male/female)	27/15	22/11
手术年龄(岁) Age(years)	57.2 $\pm$ 10.7	67.2 $\pm$ 9.6 ^①
平均随访时间(月) Mean follow-up time (months)	6.6 $\pm$ 3.8	7.6 $\pm$ 3.6

注:①与升顶组比较 $P<0.05$

Note: ①Compared with group of raising roof, $P<0.05$

Cobb角评估上颈椎曲度;C2-7 矢状面轴向距离 (sagittal vertical axis, SVA) 和 C7 倾斜角 (C7-Slope) 评估颈椎矢状面平衡。采用 Cobb 角颈椎活动度测量法^[9]测量颈椎活动度 (range of motion, ROM) (图 1)。

1.5 统计学分析

数据采用 SPSS 22.0 软件 (IBM 公司, 美国) 进行统计学分析。两组计数资料的比较采用卡方检验。计量资料使用均数 $\pm$ 标准差 ($\bar{x}\pm s$) 表示, 组内术前术后比较采用配对 t 检验, 组间比较采用独立样本 t 检验。检验水准 α 取双侧 0.05, $P<0.05$ 为差异有统计学意义。

2 结果

2.1 手术情况

75 例患者均顺利完成手术。升顶组手术节段: C3~C6 31 例, C3~C7 3 例, C4~C6 4 例, C4~C7 3 例, C5~C7 1 例; 悬吊法组手术节段: C3~C6 1 例, C3~C7 31 例, C4~C7 1 例。两组患者术中出血量差异无统计学意义 ($P>0.05$), 但升顶组患者手术时间较悬吊法组长、术后住院天数较悬吊法组短 ($P<0.05$, 表 2)。

2.2 临床疗效评定

两组患者术后末次随访时 mJOA 评分及 VAS

评分与术前比较均有明显改善, 差异有统计学意义 ($P<0.05$, 表 3); 两组间同时时间点 mJOA 和 VAS 评分比较无统计学差异 ($P>0.05$), mJOA 评分改善率亦无统计学差异 ($P>0.05$)。两组患者末次随访时 NDI 与术前比较无统计学差异 ($P>0.05$), 两组间同时时间点比较亦无统计学差异 ($P>0.05$)。

2.3 影像学评定

两组患者术前和术后末次随访时的颈椎曲度、颈椎矢状面平衡参数、颈椎 ROM 见表 4。两组术前 C0-2 Cobb 角、C2-7 Cobb 角、C2-C7 SVA、C7-Slope 和 C2-7 ROM 比较均无统计学差异 ($P>0.05$)。术后末次随访时升顶组 C7-Slop 与术前比较显著性降低 (图 2), 悬吊组与术前比较无显著性差异; 两组间比较有显著性差异 ($P<0.05$)。两组 C2-7 ROM 与术前比较均有显著性下降 ($P<0.05$), 悬吊法组下降更明显, 与升顶组比较有显著性差异 ($P<0.05$)。

3 讨论

颈后路椎管扩大椎板成形术通过扩大椎管矢状径达到对脊髓的减压, 是目前临床上治疗多节段 CSM 的重要手段之一。但是传统的颈椎后路椎管扩大椎板成形术需要广泛剥离后方韧带复合体和颈后伸肌群, 而这些肌肉韧带复合体在预防术



图 1 颈椎矢状面平衡参数的测量 a C0-2 Cobb 角: 硬腭后缘至枕骨鳞部外板最低点的连线与 C2 下终板的平行线的夹角 b C2-7 Cobb 角: C2 下终板的平行线与 C7 下终板的平行线, 两者垂线所形成的夹角 c C2-C7 SVA: C2 椎体中点的铅垂线到 C7 椎体后上角的垂直距离 d C7-Slope: C7 椎体上终板的切线与水平线的夹角

Figure 1 The measurement of sagittal balance parameters of cervical spine a C0-2 Cobb angle: The angle between the line from the posterior edge of the hard palate to the lowest point of the outer plate of the occipital squama and the parallel line of the lower endplate of C2 b C2-7 Cobb angle: The angle formed by perpendicular lines of the lower endplate of C2 and the lower endplate of C7 c C2-C7 SVA: The vertical distance from the posterior upper angle of the C7 vertebra to the plumb line across the midpoint of the C2 vertebra d C7-Slope: The angle between the tangent line of the upper endplate of the C7 vertebral body and the horizontal line

后凸畸形、维持颈椎矢状面平衡方面具有重要的作用^[9,10]。传统颈椎后路椎管扩大椎板成形术对颈后肌肉韧带复合体的破坏被认为是术后出现颈椎矢状面失平衡和活动度降低的重要原因^[11,12]。因此国内外研究者就如何保留肌肉韧带复合体,减少这些并发症的发生,对传统的颈椎后路椎管扩大椎板成形术进行了改良。我院自 2019 年起开展了颈后路“升顶式”保留双侧肌肉韧带复合体椎管扩大椎板成形联合个体化 3D 打印椎板假体置入术,取得了令人满意的效果。

3.1 升顶式椎管扩大椎板成形术对颈椎矢状面平衡的影响

颈后路椎管扩大椎板成形术以扩大椎管容积,解除脊髓压迫为目标。而在充分暴露椎板的过程中,许多术式对颈后肌肉韧带复合体造成不同

程度的破坏,而肌肉韧带复合体的破坏与颈椎矢状面失平衡有着直接的关系^[13]。

C2-C7 SVA 是衡量颈椎矢状面平衡的有效参数。本研究中升顶组患者术后末次随访时平均 C2-C7 SVA 为 15.54mm,虽然与术前相比差异无统计学意义,但平均值较术前下降;悬吊法组平均 C2-C7 SVA 为 22.35mm,较术前上升且差异有统计学意义。升顶组末次随访时的 C2-C7 SVA 小于悬吊法组,说明保留双侧肌肉韧带复合体的升顶式椎管扩大椎板成形术对维持颈椎矢状面平衡有积极作用。Tang 等^[14]发现当 C2-C7 SVA 大于 40mm 将明显影响手术疗效。虽然悬吊法组末次随访时 C2-C7 SVA 平均值远低于 40mm 这一警戒值,对脊髓减压效果影响较小,但与术前相比仍

表 2 两组手术时间、术中出血量、术后住院时间对比

Table 2 Comparisons of operative time, intraoperative blood loss, postoperative hospital stay between the two groups

	升顶组(n=42) Group of raising roof	悬吊法组(n=33) Group of suture suspension
手术时间(min) Operative time	159.7±40.8	87.3±20.1 ^①
术中出血量(ml) Intraoperative blood loss	275.7±239.2	273.4±144.3
术后住院时间(d) Postoperative hospital stay	3.2±1.4	4.6±1.0 ^①

注:①与升顶组比较 $P<0.05$

Note: ①Compared with the group of raising roof, $P<0.05$

表 3 两组患者术前、术后 mJOA 评分、VAS 及 NDI 情况

Table 3 Preoperative and postoperative mJOA score, VAS and NDI in two groups

	升顶组(n=42) Group of raising roof	悬吊法组(n=33) Group of suture suspension
mJOA评分 mJOA score		
术前 Preoperative	13.51±2.01	13.20±2.43
术后 Postoperative	15.57±1.29 ^①	14.73±2.13 ^①
改善率(%) Recovery rate	49.36±58.45	42.64±52.97
VAS评分 VAS score		
术前 Preoperative	3.69±1.08	3.82±1.47
术后 Postoperative	3.05±2.25 ^①	2.50±2.46 ^①
NDI(%)		
术前 Preoperative	10.08±7.52	12.20±8.26
术后 Postoperative	8.50±7.03	10.20±8.44

注:①与同组术前比较 $P<0.05$

Note: ①Compared with preoperation in the same group, $P<0.05$

表 4 两组患者术前和术后末次随访时的影像学指标测量结果

Table 4 The radiographic result in both groups at preoperative and final follow-up

	升顶组(n=42) Group of raising roof	悬吊法组(n=33) Group of suture suspension
C0-2 Cobb 角(°) C0-2 Cobb angle		
术前 Preoperative	18.08±7.31	18.86±7.75
术后 Postoperative	17.76±8.81	21.09±8.40
中立位 C2-7 Cobb 角(°) Neutral C2-7 Cobb angle		
术前 Preoperative	10.97±9.97	12.89±9.99
术后 Postoperative	9.56±11.04	12.98±11.35
过屈位 C2-7 Cobb 角(°) Flexion C2-7 Cobb angle		
术前 Preoperative	-13.19±12.16	-9.92±12.06
术后 Postoperative	-11.41±13.01	-4.29±12.73 ^{①②}
过伸位 C2-7 Cobb 角(°) Extension C2-7 Cobb angle		
术前 Preoperative	24.31±11.10	22.03±9.27
术后 Postoperative	19.69±10.57 ^①	19.63±10.80 ^①
C2-7 颈椎活动度(°) C2-7 range of motion		
术前 Preoperative	37.50±13.61	31.95±12.56
术后 Postoperative	31.10±13.50 ^①	23.19±9.84 ^{①②}
C2-C7 SVA(mm)		
术前 Preoperative	16.98±8.96	21.09±10.59
术后 Postoperative	15.54±11.68	22.35±10.61 ^②
C7-Slope(°)		
术前 Preoperative	21.42±7.18	24.63±8.60
术后 Postoperative	19.08±6.67 ^①	25.01±9.42 ^②

注:①与同组术前比较 $P<0.05$;②与同时点升顶组比较 $P<0.05$

Note: ①Compared with preoperation in the same group, $P<0.05$;

②Compared with the group of raising roof, $P<0.05$

会促进颈椎矢状面失平衡进程。

T1-Slope 是近年来引入评价颈椎整体矢状面平衡的重要参数,亦可表示颈椎前倾的程度^[15]。在站立位 X 线片上测量 T1-Slope 时由于双肩遮挡,胸骨上缘及 T1 椎体辨认不清,从而影响了其临床应用价值^[16]。Tamai 等^[17]发现 C7-Slope 同 T1-Slope 具有强相关性,C7-Slope 在衡量颈椎矢状面平衡方面具有同 T1 倾斜角相似的临床意义,因此 C7-Slope 可作为评估整体矢状面序列的一个重要指标。本研究中立颈组术后末次随访时 C7-Slope 较术前明显降低,悬吊法组患者术后与术前

比较差异无统计学意义,术后末次随访时升顶组 C7-Slope 小于悬吊法组。再一次验证了升顶组在维持颈椎矢状面平衡方面优于悬吊法组。颈后路椎管扩大椎板成形术后出现下颈椎前倾,机体将通过上颈椎过伸以代偿颈椎的前倾失衡,使视线保持水平。升顶组保留了双侧肌肉韧带复合体,有足够的颈后伸肌群力量来维持矢状面平衡,而悬吊法组颈后肌肉遭到了破坏,使这种代偿机制很容易失衡,从而可能在长期的随访中出现后凸畸形和神经功能障碍等。

2010 年李锋等^[18,19]报道了一种颈后路经肌间

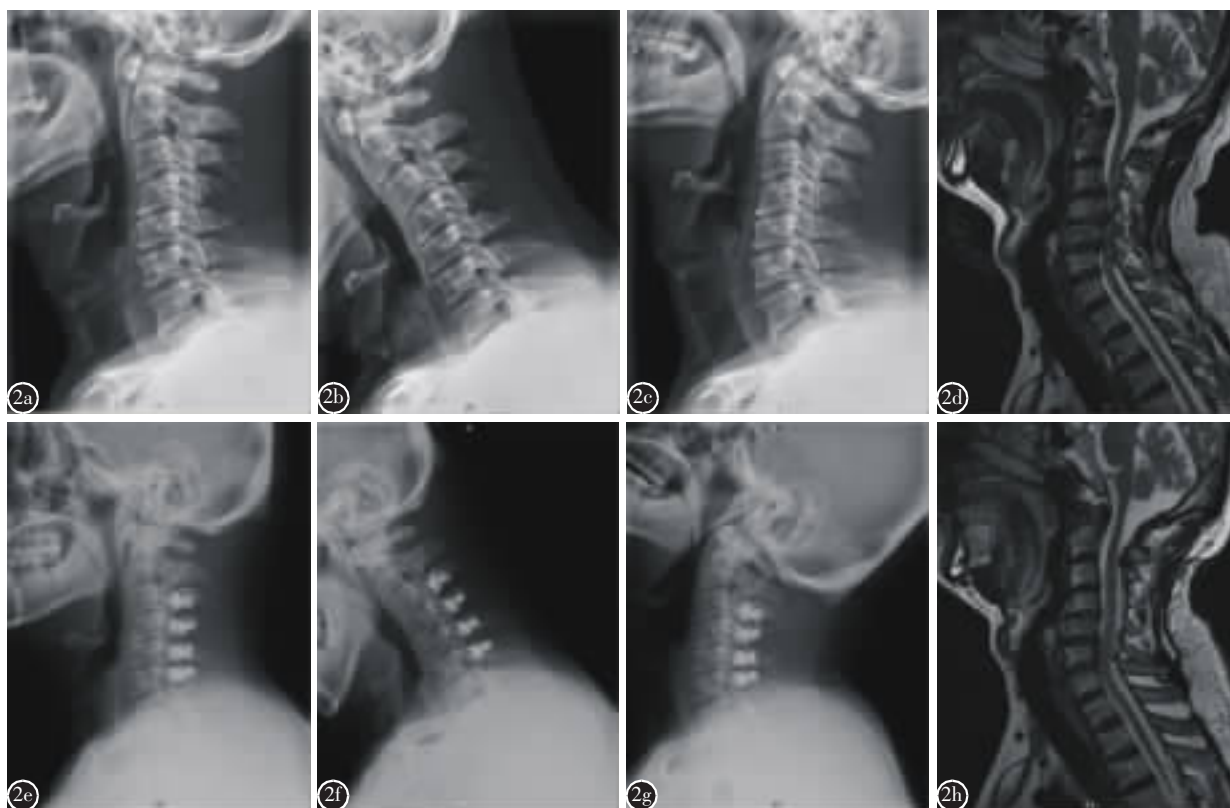


图 2 患者男,56 岁,双上肢麻木 10 年余,加重 1 年,行颈后路 C3~C6“升顶式”椎管扩大椎板成形术 **a** 术前颈椎侧位 X 线片示 C2~C7 SVA 为 20.81mm,C7-Slope 为 26.8° **b、c** 术前颈椎过伸过屈位 X 线片示颈椎 ROM 为 51.8° **d** 术前颈椎 MRI 示 C3~C7 脊髓受压,明显变细 **e** 术后 6 个月颈椎侧位 X 线片示内置物固定良好,C2~C7 SVA 为 13.26mm,C7-Slope 为 20.9° **f、g** 术后 6 个月颈椎过伸过屈位 X 线片示颈椎 ROM 为 57.7° **h** 术后 6 个月颈椎 MRI 示脊髓受压解除

Figure 2 A 56 year-old male, presented with bilateral upper extremities numbness for 10 years and aggravated for 1 years, underwent posterior C3-C6 cervical ‘raising roof’ laminoplasty **a** Preoperative lateral radiograph of cervical vertebrae showed that the C2-C7 SVA was 20.81mm and the C7-Slope was 26.8° **b, c** Preoperative cervical dynamic cervical radiographs showed that the range of motion of cervical spine was 51.8° **d** Preoperative MRI showed spinal cord getting significantly thin with pressure **e** Six months after surgery, dynamic cervical radiographs showed that the implants were well fixed, the C2-C7 SVA was 13.26mm and the C7-Slope was 20.9° **f, g** Six months after surgery, cervical dynamic cervical radiographs showed that the range of motion of cervical spine was 57.7° **h** Six months after surgery, MRI showed spinal cord compression was relieved

隙保留颈后伸肌群入路的颈椎椎板成形术治疗 CSM 患者 20 例和颈椎后纵韧带骨化症患者 32 例,长期的随访结果显示该术式在神经功能症状的改善和颈椎曲度的维持等方面优于传统后正中入路单开门椎管扩大椎板成形术。2010 年张春霖等^[20]对行内窥镜下微创颈椎管扩大椎板成形术患者进行中远期随访,发现 C2-7 Cobb 角末次随访时平均 7.8° ,与术前平均 7.2° 相比差异无统计学意义,说明术后颈椎生理曲度得到保护并且长期维持良好。本研究中两组患者末次随访时矢状面 C2-7 Cobb 角与术前相比差异均无统计学意义,与既往的研究结果类似,且两组患者矢状面 C0-2 Cobb 角组内术前术后比较及组间比较差异均无统计学意义,说明升顶组和悬吊法组对颈椎生理曲度的维持具有相似的效果。

3.2 升顶式椎管扩大椎板成形术对颈椎 ROM 的影响

颈后路椎管扩大椎板成形术后颈椎 ROM 的丢失是非常常见的并发症。本研究中两组患者术后颈椎 ROM 均较术前明显降低($P<0.05$),但末次随访时悬吊法组颈椎 ROM 较升顶组更差($P<0.05$)。可能由于手术后颈后伸肌群与韧带间相互黏连、肌肉痉挛、患者对创伤的恐惧等共性问题,不可避免地导致术后颈椎 ROM 降低^[21]。但升顶组经肌间隙入路相对悬吊法组更加微创,因此对颈椎 ROM 的影响小于悬吊法组。

3.3 升顶式椎管扩大椎板成形术对神经功能恢复的影响

基于保留肌肉韧带复合体的颈后路椎管扩大椎板成形术的改良术式可有效扩大椎管容积、实现神经减压、改善神经功能^[22]。本研究中升顶组和悬吊法组术后末次随访时 mJOA 评分及 VAS 与术前比较均有明显改善($P<0.05$),两组间术前及术后的 mJOA 和 VAS 评分、mJOA 评分改善率差异均无统计学意义($P>0.05$)。说明升顶组和悬吊法组具有相似的椎管减压、神经功能改善的作用。升顶组通过经肌间隙入路保留了双侧肌肉韧带复合体,但术后 VAS 评分和 NDI 与保留单侧肌肉韧带复合体的椎管扩大椎板成形术相比差异不显著,可能由于两组患者术前均无明显颈痛且术后早期开始锻炼,减轻了颈部的僵硬疼痛,另外,和本研究术后随访时间较短有一定的关系。

本研究中排除了明显颈痛症状的患者,其原

因是椎板成形术中对肌肉的刺激和损伤致使术后颈痛无好转或者加重,不利于患者术后早期颈部活动及颈椎曲度的恢复。本研究为临床回顾性研究,目前为止,随访 1 年及以上病例数较少,尚需后续大样本前瞻性对照研究和深入的生物力学研究进一步证实。本研究中升顶组患者平均年龄低于悬吊法组,年龄差异可能对患者术后恢复情况产生一定影响。该术式作为一种新术式,在早期阶段手术时间比传统颈后路单开门椎管扩大椎板成形术长,随着熟练度的提高,手术时间应会进一步缩短。

综上所述,颈后路经肌间隙入路“升顶式”椎管扩大椎板成形术保留了双侧颈后肌肉韧带复合体,与传统“关节囊悬吊法”颈后路单开门椎管扩大椎板成形术相比,在获得术后早期相同神经功能改善的同时,对颈椎矢状面平衡及颈椎 ROM 的维持更具优势。

4 参考文献

1. Chen YC, Kuo CH, Cheng CM, et al. Recent advances in the management of cervical spondylotic myelopathy: bibliometric analysis and surgical perspectives[J]. J Neurosurg Spine, 2019, 31(3): 299-309.
2. Hirabayashi K, Watanabe K, Wakano, et al. Expansive open-door laminoplasty for cervical spinal stenotic myelopathy [J]. Spine(Phila Pa 1976), 1983, 8(7): 693-699.
3. Yoon ST, Hashimoto RE, Raich A, et al. Outcomes after laminoplasty compared with laminectomy and fusion in patients with cervical myelopathy: a systematic review [J]. Spine(Phila Pa 1976), 2013, 38(22 Suppl 1): S183-194.
4. Grosso MJ, Hwang R, Mroz T, et al. Relationship between degree of focal kyphosis correction and neurological outcomes for patients undergoing cervical deformity correction surgery [J]. J Neurosurg Spine, 2013, 18(6): 537-544.
5. Vernon H, Mior S. The neck disability index: a study of reliability and validity[J]. J Manipulative Physiol Ther, 1991, 14(7): 409-415.
6. Scott J, Huskisson EC. Graphic representation of pain [J]. Pain, 1976, 2(2): 175-184.
7. Tan LA, Straus DC, Traynelis VC. Cervical interfacet spacers and maintenance of cervical lordosis [J]. J Neurosurg Spine, 2015, 22(5): 466-469.
8. Machino M, Yukawa Y, Hida T, et al. Cervical alignment and range of motion after laminoplasty: radiographical data from more than 500 cases with cervical spondylotic myelopathy and a review of the literature[J]. Spine(Phila Pa 1976), 2012, 37(20): E1243-1250.
9. Nolan JP Jr, Sherk HH. Biomechanical evaluation of the ex-

- tensor musculature of the cervical spine [J]. *Spine(Phila Pa 1976)*, 1988, 13(1): 9–11.
10. Whitehill R, Moran DJ, Fechner RE, et al. Cervical ligamentous instability in a canine in vivo model [J]. *Spine(Phila Pa 1976)*, 1987, 12(10): 959–963.
 11. Wang M, Luo XJ, Deng QX, et al. Prevalence of axial symptoms after posterior cervical decompression: a Meta-analysis[J]. *Eur Spine J*, 2016, 25(7): 2302–2310.
 12. Zhang JT, Li JQ, Niu RJ, et al. Predictors of cervical lordosis loss after laminoplasty in patients with cervical spondylotic myelopathy[J]. *Eur Spine J*, 2017, 26(4): 1205–1210.
 13. 林圣荣, 周非非, 孙宇, 等. 颈后路单开门椎管扩大椎板成形术后颈椎矢状面平衡的变化[J]. *中华医学杂志*, 2014, 94(35): 2726–2730.
 14. Tang JA, Scheer JK, Smith JS, et al. The impact of standing regional cervical sagittal alignment on outcomes in posterior cervical fusion surgery[J]. *Neurosurgery*, 2015, 76(Suppl 1): S14–21.
 15. Knott PT, Mardjetko SM, Tschy F. The use of the T1 sagittal angle in predicting overall sagittal balance of the spine [J]. *Spine J*, 2010, 10(11): 994–998.
 16. 程招军, 彭兵, 范俊超, 等. 脊髓型颈椎病患者颈椎 MRI 与 X 线片矢状位参数的对比分析 [J]. *中国脊柱脊髓杂志*, 2016, 26(7): 591–595.
 17. Tamai K, Buser Z, Paholpak P, et al. Can C7 slope substitute the T1 slope? an analysis using cervical radiographs and kinematic MRIs [J]. *Spine(Phila Pa 1976)*, 2018, 43(7): 520–525.
 18. 李锋, 徐勇, 熊伟, 等. 后路经肌间隙保留颈后伸肌群入路的颈椎椎板成形术的技术要点及临床应用 [J]. *骨科*, 2019, 10(5): 412–417.
 19. 徐勇, 李锋, 熊伟, 等. 经肌间隙入路与后正中入路颈椎单开门椎管扩大椎板成形术治疗颈椎后纵韧带骨化症的疗效比较[J]. *中国脊柱脊髓杂志*, 2020, 30(3): 227–233.
 20. 张春霖, 魏昱博, 李东哲, 等. 内窥镜下微创颈椎管扩大成形术治疗多节段脊髓型颈椎病的中长期疗效[J]. *中国脊柱脊髓杂志*, 2018, 28(6): 481–487.
 21. Maeda T, Arizono T, Saito T, et al. Cervical alignment, range of motion, and instability after cervical laminoplasty [J]. *Clin Orthop Relat Res*, 2002, 401: 132–138.
 22. 余翔, 姜亮, 刘忠军. 颈后路保留肌肉韧带复合体椎管扩大成形术的研究进展 [J]. *中国脊柱脊髓杂志*, 2017, 27(9): 842–845.
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- Spine J*, 2016, 16(1): 1–9.
13. Goel A, Kulkarni AG, Sharma P. Reduction of fixed atlantoaxial dislocation in 24 cases: technical note[J]. *J Neurosurg Spine*, 2005, 2(4): 505–509.
 14. Goel A, Desai KI, Muzumdar DP. Atlantoaxial fixation using plate and screw method: a report of 160 treated patients[J]. *Neurosurgery*, 2002, 51(6): 1351–1357.
 15. Goel A, Shah A. Atlantoaxial joint distraction as a treatment for basilar invagination: a report of an experience with 11 cases[J]. *Neurol India*, 2008, 56(2): 144–150.
 16. Yin YH, Yu XG, Zhou DB, et al. Three-dimensional configuration and morphometric analysis of the lateral atlantoaxial articulation in congenital anomaly with occipitalization of the atlas[J]. *Spine(Phila Pa 1976)*, 2012, 37(3): E170–E173.
 17. Chandra PS, Goyal N, Chauhan A, et al. The severity of basilar invagination and atlantoaxial dislocation correlates with sagittal joint inclination, coronal joint inclination, and craniocervical tilt: a description of new indexes for the craniocervical junction[J]. *Neurosurgery*, 2014, 10(Suppl 4): 621–630.
 18. Yin YH, Yu XG. The severity of basilar invagination and atlantoaxial dislocation correlates with sagittal joint inclination, coronal joint inclination, and craniocervical tilt: a description of new indices for the craniocervical junction[J]. *Neurosurgery*, 2015, 76(2): E233–E235.
 19. Salunke P, Sharma M, Sodhi HB, et al. Congenital atlantoaxial dislocation: a dynamic process and role of facets in irreducibility[J]. *J Neurosurg Spine*, 2011, 15(6): 678–685.
 20. Laheri V, Chaudhary K, Rathod A, et al. Anterior transoral atlantoaxial release and posterior instrumented fusion for irreducible congenital basilar invagination [J]. *Eur Spine J*, 2015, 24(12): 2977–2985.
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