Cite as: Fang W, Xu SG, Liu G. Two types of anterior cervical fusion for the treatment of two-segment cervical spondylotic myelopathy: Clinical efficacy and radiographic analysis [J]. Chin J Clin Res, 2024, 37(5):739-742,750.
DOI: 10.13429/j.cnki.cjcr.2024.05.018

Two types of anterior cervical fusion for the treatment of two-segment cervical spondylotic myelopathy: clinical efficacy and radiographic analysis

FANG Wei* , XU Shigang, LIU Gang

*Department of Orthopedics, Nanjing Jiangbei Hospital Affiliated to Xinglin College, Nantong University, Nanjing, Jiangsu 211500,China

Corresponding author: LIU Gang, E-mail: 184333190@qq.com

Abstract: Objective To compare the effectiveness of anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF) in the treatment of two-segment cervical spondylotic myelopathy (CSM). **Methods** Clinical data of 58 patients with two-segment CSM Clinical data of 58 patients with two-segment CSM treated from January 2020 to December 2022 at the Affiliated Nanjing Jiangbei Hospital of Xinglin College, Nantong University were retrospectively analyzed. Patients were divided into ACDF group (n=30) and ACCF group (n=28) based on the surgical procedure. Perioperative data (hospitalization time, intraoperative blood loss and operation duration), clinical parameters [neck disability index (NDI) score and visual analog scale (VAS) score], and radiographic data (segmental angle, T1 slope, C2-7 sagittal vertical axis, C2-7 cervical lordosis, and fusion rate) were compared between the two groups. **Results** The operation time [(107.38±12.29) min *vs* (118.37 ±11.36) min, t=3.529, P<0.01] and intraoperative blood loss [(58.36±24.31) mL *vs* (77.73±27.51) mL, t=2.846, P<0.01] were lower in the ACDF group than in the ACCF group. Both groups showed significantly decreased NDI and VAS scores postoperatively compared to preoperative scores (P<0.05), but the difference between the two groups was not statistically significant (P>0.05). The ACDF group showed significant improvements in segmental angle and C2-7 cervical lordosis postoperatively and at the last follow-up, which were greater than those in the ACCF group (P<0.05). There was no statistically significant difference in T1 slope, C2-7 sagittal vertical axis, and fusion rate between the two groups (P>0.05). **Conclusion** In the treatment of two-segment CSM, ACDF has less surgical trauma than ACCF and is more advantageous in restoring cervical lordosis. For cases without significant bony spinal cord compression, ACDF is a preferable surgical option for two-segment CSM.

Keywords: Anterior cervical approach; Cervical spondylotic myelopathy; Double segment; Radiography
Fund program: Nanjing Health Technology Development Special Fund Project (YKK21213)

Cervical spondyloic myelopathy (CSM) is a type of cervical spondylosis that results in spinal cord compression or ischaemia and spinal cord dysfunction due to cervical disc herniation, Bone spurs at the posterior margin of the vertebral body, bone spurs at the posterior margin of hyperplasia, hyperplasia of the articulation, ossification of the posterior longitudinal ligament, hypertrophy or calcification of the ligamentum flavum[1-2]. However, the optimal surgical strategy for CSM remains controversial. The choice of anterior, posterior, and combined anterior and posterior decompression depends largely on the sagittal position of the cervical spine, the location of spinal cord compression, and the severity of the disease[3]. In general, most spine surgeons opt for anterior cervical surgery , which consists of anterior cervical discectomy fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF), except for multi-segment cervical compression. These two procedures are now widely recognized as the standard treatment of CSM[4].

In anterior cervical spine surgery, when the patient has a long history of disease, significant degeneration, and large bone formation at the posterior margin of the vertebral body (e.g., posterior longitudinal ligament ossification), these patients often have narrowed intervertebral space, and if ACDF is chosen, the narrow surgical space will increase the risk of the procedure, and even if a submerged decompression is performed, it is often difficult to achieve complete decompression. These patients are often treated with the ACCF procedure, which provides more extensive decompression and a higher fusion rate[5]. The choice of anterior surgical approach for two-segment CSM remains controversial. In clinical treatment, ACCF is performed when surgeons consider that ACDF may not be able to decompress completely. However, it also brings certain problems, such as higher postoperative cervical lordosis and titanium mesh settling[6]. Postoperative sagittal parameters play an important role in patient prognosis and quality of life. At the same time, sagittal imbalance is also an important factor leading to poor prognosis[7-8]. Among the cervical sagittal alignment parameters, many studies have emphasized that T1 slope, C2-7 sagittal vertical axis, and C2-7 cervical lordosis have a positive effect on patient's prognosis[9] . In this study, perioperative data, clinical and radiographic parameters of patients with two-segment CSM who underwent

ACDF and ACCF procedures were retrospectively analyzed in order to evaluate the effectiveness of these two surgeries.

1 Materials and methods

1.1 General data

The clinical data of 58 patients diagnosed with two-segment CSM admitted to Nanjing Jiangbei Hospital Affiliated to Xinglin College, Nantong University from January 2020 to December 2022 were retrospectively analyzed. The cases were divided into the ACDF group (n=30) and ACCF group (n=28) according to the surgical methods. There was no significant difference between the preoperative general information of patients in the two groups (P>0.05). **[Table 1]**

1.2 Inclusion and exclusion criteria

Inclusion criteria: (1) no coagulation disorders; (2) with CSM diagnosed by X-ray, CT, and MRI, with radiographic examinations showing that the spinal cord of two adjacent segments was compressed by herniated intervertebral discs, proliferating osteophytes at the posterior border of the vertebral body, and minor ossification of the posterior longitudinal ligament; (3) ineffective conservative treatments for 3 months, and finally underwent ACDF or ACCF surgery.

Exclusion criteria: (1) with trauma-induced compression of the cervical spinal cord; (2) with cervical vertebral body deformity, tumors, cervical spine infections, or severe cervical posterior longitudinal ligament ossification; (3) with combidities (e.g., severe osteoporosis); (4) unable to tolerate surgery or had contraindications to surgery; (5) loss of follow-up or death due to other factors.

1.3 Surgical methods

After general anesthesia, the patient was placed in the supine position with the neck in hyper-extension. A transverse incision of approximately 5 cm was made in the right neck and the platysma was incised. The carotid sheath and visceral compartment were bluntly dissected to expose the appropriate intervertebral space, the pin was positioned under fluoroscopy using a C-arm machine, and the expansion screws were placed in the superior and inferior vertebral bodies of the appropriate segment. An intervertebral spacer was placed and the intervertebral space was moderately expanded.ACDF group: First, the cervical disc of the upper intervertebral space was removed, and the upper and lower cartilaginous endplates were treated. The bone spurs on the posterior edge of the vertebral body were scraped off with a curette. The hypertrophic posterior longitudinal ligament was removed and the dural sac was explored to ensure good decompression of the spinal canal. The height of the corresponding intervertebral space was measured, and an appropriate size for an ROI-C interbody fusion device was selected after trial fitting. The debris removed during decompression was placed in the fusion device and the intervertebral spacer was removed. The locking insert (titanium alloy) (LDR, France) was placed and the lower intervertebral space was treated in the same way.ACCF group: First, the two diseased discs were removed, and the responsible vertebral body was cut; the posterior longitudinal ligament was incised with a hook knife, and the bone spurs on the posterior edge of the vertebral body were removed. The hypertrophic posterior longitudinal ligament was carefully removed and a suitable length of vertebral cage (Sichuan Guona Technology Co., Ltd.) was selected. The debris removed during the decompression process was placed in the cage, and a bone groove was made; the intervertebral space was expanded to restore the height of the cervical spine, and the anterior cervical plate was fixed. After internal fixation, both groups were left with a single incision drainage tube, and bleeding was stopped entirely before suturing layer by layer. The same senior spine surgeon performed both surgeries.

Postoperative management: All patients received prophylactic antibiotics for 24 hours after surgery and nutritional support, analgesia, and other symptomatic treatments. During bed rest, they received pressure therapy for both lower limbs. The drainage tube was removed within 48 hours of surgery, and the patients were assisted to walk with a neck brace; the rehabilitation department instructed the patients to strengthen their limb function exercises and advised them to wear a neck brace for 1.5 months after surgery.

1.4 Observations and radiographic parameter measurements

Perioperative data and clinical score: length of hospitalization, intraoperative blood loss and operation duration, Neck Disability Index Score (NDI) , and Visual Analog Score (VAS) for pain.

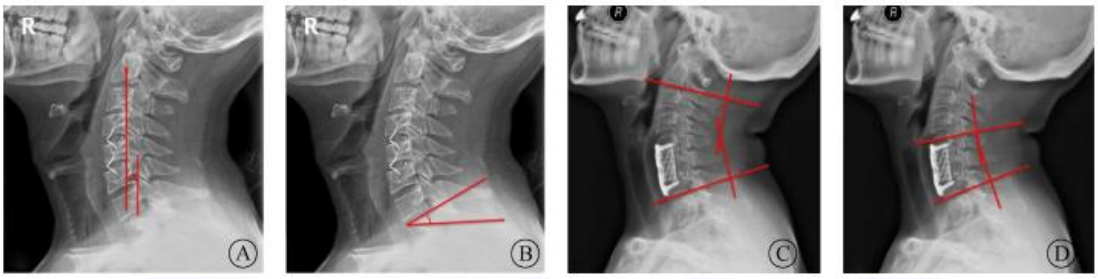
Tab.1 Comparison of general information of group patients

Item		ACDF group (n=30)	ACCF group (n=28)	x^2 /t value	P value
Gender (male/female,case)		17/13	15/13	0.056	0.813
Age (years, $\bar{x}$ ±s)		58.71±7.53	61.15±8.69	1.674	0.260
Duration of disease (months, $\bar{x}$ ±s)		11.71 ± 3.53	10.23±2.53	2.007	0.071
Surgical segments (case)	C3-5	7	6		
	C4-6	15	14	0.043	0.979
	C5-7	8	8		
Follow-up time (months, $\bar{x}$ ± s)		14.78±5.46	16.24±7.41	1.410	0.164

Radiographic parameters **[Figure 1]**: segmental angle (angle created by two lines parallel to the upper and lower endplates of the two vertebrae above and below the operated segmental body on lateral cervical radiographs), T1 slope (angle between the horizontal line and the upper endplate of T1), longitudinal distance in the C2-7 sagittal vertical axis (distance from the plumbline of the center of C2 to the plumbline of the posterior-superior horn of C7), C2-7 cervical lordosis (angle between the parallel lines of the inferior endplates of C2 and C7) and fusion rate (interbody fusion was scored on lateral radiographs at the last follow-up (≥6 months) according to the Bridwell-Lenke grading. Grade 1 was considered completely fused, the endplates became blurred, and trabecular continuity and bony bridging could be observed in the intervertebral space).

1.5 Statistical methods

SPSS 20.0 software was used to process the data. Measurement data were expressed as $\bar{x}\pm s$, independent sample *t*-test was used between groups. Gender and surgical segment were tested by Chi-square test and adjusted Chi-square test. $P < 0.05$ was regarded as statistically significant difference.



Note: A, C2-7 sagittal vertical axis (distance between the plumb line from the center of C_2 to the plumb line of the posterior-superior angle of C7); B, segmental angle (angle created on lateral cervical radiographs by two lines parallel to the superior and inferior endplates of the two vertebral bodies above and below the operated segmental body); C, C2-7 cervical lordosis (the angle between the parallel lines of the superior and inferior endplates of C2 and C7); and D, T_1 slope (the angle between the horizontal line and the superior endplate of T_1).

Fig.1 Radiographic parameters

2 Results

2.1 Perioperative data and clinical scores

In terms of the perioperative period, the operation duration and intraoperative blood loss in the ACDF group were lower than that in the ACCF group ($P < 0.05$). The postoperative NDI and VAS scores of both groups were lower than the preoperative period ($P < 0.05$), but the difference between the two groups was not statistically significant ($P > 0.05$). **[Table 2]**

2.2 Radiographic parameters

The segmental angle and C2-7 anterior convexity angle of the ACDF group at postoperative and final follow-up were significantly improved compared with those of the preoperative period and were greater than those of the ACCF group ($P < 0.05$). There was no significant difference in T1 slope, C2-7 sagittal vertical axis, and fusion rate ($P > 0.05$). **[Table 3]**

Tab.2 Comparison of perioperative data and clinical scores between two groups

Group	Case	Operation duration (min)	Intraoperative blood loss (mL)	Length of hospitalization (day)	NDI score		VAS score	
					preoperative	postoperative	preoperative	postoperative
ACDF group	30	107.38±12.29	58.36±24.31	7.31±1.76	13.41±2.76	11.14±4.32[a]	5.31±1.41	2.31±1.08[a]
ACCF group	28	118.37±11.36	77.73±27.51	6.59±1.34	13.16±1.31	11.48±3.89[a]	6.11±2.16	2.31±1.36[a]
t value		3.529	2.846	1.760	0.445	0.315	1.681	0.000
P value		<0.001	0.006	0.084	0.666	0.755	0.098	1.000

Note: Compared with preoperative,[a] $P < 0.05$.

Tab.3 Comparison of radiographic parameters between two groups of patients

Group	Case	Segment angle (°)			T1 Slope (°)		
		Preoperative	Postoperative	Final follow-up	Preoperative	Postoperative	Final follow-up
ACDF group	30	6.36±3.31	9.73±2.41[a]	8.24±3.31[a]	28.15±8.82	29.48±7.39	29.17±9.38
ACCF group	28	5.71±2.86	6.01±3.34	5.31±2.73	27.41±7.76	26.54±8.31	26.24±6.32
t value		0.802	4.841	3.663	0.340	1.420	1.385
P value		0.426	<0.001	<0.001	0.735	0.160	0.172

Group	Case	C2-7 sagittal vertical axis (mm)			C2-7 cervical lordosis (°)			Integration rate (%)
		Preoperative	Postoperative	Final follow-up	Preoperative	Postoperative	Final follow-up	
ACDF group	30	2.36±1.33	2.73±1.01	2.45±1.41	14.35±5.51	19.63±6.61[a]	18.78±5.81[a]	93.3
ACCF group	28	1.91±1.06	2.19±1.14	2.11±1.09	13.31±4.78	14.59±4.34	14.11±3.54	96.4
t value		1.430	1.904	1.031	0.769	3.454	3.724	0.004
P value		0.162	0.062	0.307	0.445	0.001	0.001	0.951

Note: Compared with preoperative,[a] $P < 0.05$.

3 Discussion

The csymptoms of CSM are mainly caused by spinal cord compression due to herniated intervertebral discs, degeneration of the involved vertebrae and articular eminences, and osteophyte formation of the posterior longitudinal ligament. Clinically, anterior cervical surgery (ACDF and ACCF) can effectively alleviate the symptoms of nerve compression and correct the problem of cervical kyphosis in patients[10]. For mild to moderate cervical disc herniation or degeneration-induced CSM, the ACDF procedure is mostly used, which leads to less trauma, less blood loss, and can directly remove the compression-causing material in the front of the spinal canal, with a good decompression effect. At the same time, the physiological lordosis of the cervical spine can be restored to a certain extent, precipitating the functional recovery of the spinal cord. However, the operation space is limited due to the small field of view in the hands of this procedure, and thus difficult to completely remove the large bone cumbers[11]. For the anterior compression tissue of the spinal canal from the proliferation of bony cords at the posterior margin of the vertebral body, calcified posterior longitudinal ligament, and huge disc herniation, it is difficult to completely decompress with the ACDF. The ACCF, through the sub-total resection of the cervical vertebral body, can sufficiently decompress and extensively remove the compression-causing materials at the posterior margin of the vertebral body under the conditions of a better field of view[12]. However, this procedure destroys the anterior-mid column of the vertebral body, and is prone to dislocation and loosening of the fixed titanium mesh, settling of the implanted titanium mesh, and reduction of the physiologic curvature of the cervical spine or even kyphosis[13].

In this study, we found that both ACDF and ACCF achieved satisfactory clinical outcomes and fusion rates for two-segment CSM, with a significant decrease in NDI and VAS scores in both groups. As for the operation duration and intraoperative blood loss, ACDF was superior to ACCF. This suggests that the ACDF procedure is less invasive, which would be favorable to the patients' enhanced recovery after surgery.

Regarding cervical sagittal parameters, Lee *et al.*[14] found that postoperative C2-7 sagittal vertical axis was closely related to patients' quality of life, including NDI scores and JOA scores. In addition, it has been reported that T1 slope can be used as an indicator to evaluate sagittal balance and guide surgical protocols. T1 slope affects the curvature of the cervical spine to ensure that the gravity center of the head is in a balanced position[15]. Previous studies have reported that surgical intervention to maintain the anterior camber angle of C2-7 segments has a positive impact on patient prognosis. In conclusion, among the sagittal parameters of the cervical spine, T1 slope, C2-7 sagittal vertical axis, and C2-7 cervical lordosis have important roles. In this study, there was no significant improvement in T1 slope and C2-7 sagittal vertical axis. In contrast, in the ACDF group, the maintenance of surgical segmental angle and C2-7 cervical lordosis was superior to that in the ACCF group. The restoration of physiological curvature is the basis for maintaining the normal biomechanics of the cervical spine, and the restoration of curvature can indirectly restore the volume of the spinal canal, thus indirectly decompressing the spinal cord. The maintenance of cervical physiological curvature can prevent the occurrence of postoperative axial pain and degenerative changes in neighboring segments. Although ACCF has the advantages of large operating space and adequate decompression, it causes more damage to the anterior column structures, making bone grafting more difficult than intervertebral grafting. If the decompression range is long, there is a risk of stress changes leading to displacement of the implant, regardless of whether iliac bone or long titanium mesh is taken for bone grafting. However, the choice of procedure depends on the characteristics of the cervical spinal cord compression. For patients with ossification of the posterior longitudinal ligament of the cervical vertebrae and large or calcified intradiscal herniations, the ACCF procedure is usually preferred. With the development of microscopic techniques, the indications for ACCF have become broader with the help of microscopy. Therefore, in most cases, the ACDF procedure serves as a worthwhile alternative to surgical treatment for patients with CSM in two adjacent segments.

Conflict of interest None

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Submission received:2024-01-03/ **Revised:**2024-02-11

·论　著·

两种颈椎前路融合术治疗双节段脊髓型颈椎病的临床疗效与影像学分析

方威[1]，　徐士刚[1]，　刘刚[2]

1. 南通大学杏林学院附属南京江北医院骨科，江苏 南京 210048；

2. 宿州市第一人民医院骨科，安徽 宿州 234000

摘要：目的　对比分析颈前路椎间盘切除椎间融合术（ACDF）和颈前路椎体次全切除椎间融合术（ACCF）治疗双节段脊髓型颈椎病的疗效。**方法**　回顾性分析 2020 年 1 月至 2022 年 12 月南通大学杏林学院附属南京江北医院收治的 58 例双节段脊髓型颈椎病患者的临床资料，按手术方式分为 ACDF 组 30 例和 ACCF 组 28 例，对比分析两组患者围手术期数据（住院时间、术中出血量和手术时间）、临床参数［颈部残疾指数评分（NDI）和疼痛视觉模拟评分（VAS）］和影像学数据（节段角、T_1 斜率、$C_{2\text{-}7}$矢状位纵轴距、$C_{2\text{-}7}$前凸角和融合率）。**结果**　ACDF 组的手术时间［（107.38±12.29）min *vs*（118.37±11.36）min，$t=3.529$，$P<0.01$］短于 ACCF 组，术中出血量低于 ACCF 组［（58.36±24.31）mL *vs*（77.73±27.51）mL，$t=2.846$，$P<0.01$］。两组的术后 NDI 评分及 VAS 评分均低于术前（$P<0.05$），但两组差异无统计学意义（$P>0.05$）。ACDF 组术后、末次随访的节段角及 $C_{2\text{-}7}$前凸角均较术前显著改善，且优于 ACCF 组（$P<0.05$）。两组 T_1 斜率、$C_{2\text{-}7}$矢状位纵轴距、融合率差异无统计学意义（$P>0.05$）。**结论**　ACDF 在治疗双节段脊髓型颈椎病中，较 ACCF 创伤更小，且在恢复颈椎生理曲度方面较 ACCF 更有优势。对于无明显骨性脊髓压迫，ACDF 在治疗双节段脊髓型颈椎病中是一种值得选择的术式。

关键词：颈椎前路；脊髓型颈椎病；双节段；椎间融合术；影像学

中图分类号：R681.5　**文献标识码：**A　**文章编号：**1674-8182(2024)05-0739-05

Two types of anterior cervical fusion for the treatment of two-segment cervical spondylotic myelopathy: clinical efficacy and imaging analysis

FANG Wei*, XU Shigang, LIU Gang

** Department of Orthopedics, Nanjing Jiangbei Hospital Affiliated to Xinglin College, Nantong University, Nanjing, Jiangsu 210048, China*

Corresponding author: LIU Gang, E-mail: 184333190@qq.com

Abstract: Objective　To compare the effectiveness of anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF) in the treatment of two-level cervical spondylotic myelopathy. **Methods**　Clinical data of 58 patients with two-level cervical spondylotic myelopathy treated from January 2020 to December 2022 at Nanjing Jiangbei Hospital Affiliated to Xinglin College, Nantong University were retrospectively analyzed. Patients were divided into ACDF group ($n=30$) and ACCF group ($n=28$) based on the surgical procedure. Perioperative data (hospitalization time, intraoperative blood loss and operation time), clinical parameters [neck disability index (NDI) score and visual analog scale (VAS) score], and imaging data (segmental angle, T1 slope, $C_{2\text{-}7}$ sagittal vertical axis, $C_{2\text{-}7}$ cervical lordosis, and fusion rate) were compared between the two groups. **Results**　The operation time [(107.38±12.29) min *vs* (118.37±11.36) min, $t=3.529$, $P<0.01$] and intraoperative blood loss [(58.36±24.31) mL *vs* (77.73±27.51) mL, $t=2.846$, $P<0.01$] were lower in the ACDF group than in the ACCF group. Both groups showed significantly decreased NDI and VAS scores postoperatively compared to preoperative scores ($P<0.05$), but the difference between the two groups was not statistically significant ($P>0.05$). The ACDF group showed significant

DOI: 10.13429/j.cnki.cjcr.2024.05.018

基金项目：南京市卫生科技发展专项资金项目（YKK21213）

通信作者：刘刚，E-mail：184333190@qq.com

出版日期：2024-05-20

QR code for English version

improvements in segmental angle and $C_{2\sim7}$ cervical lordosis postoperatively and at the last follow-up, which were greater than those in the ACCF group ($P<0.05$). There was no statistically significant difference in T1 slope, $C_{2\sim7}$ sagittal vertical, and fusion rate between the two groups ($P>0.05$). **Conclusion** In the treatment of two-level cervical spondylotic myelopathy, ACDF has less surgical trauma than ACCF and is more advantageous in restoring cervical lordosis. For cases without significant bony spinal cord compression, ACDF is a preferable surgical option for two-level cervical spondylotic myelopathy.

Keywords: Anterior cervical approach; Cervical spondylotic myelopathy; Double segment; Interbody fasion; Imaging

Fund program: Nanjing Health Technology Development Special Fund Project (YKK21213)

脊髓型颈椎病是由于颈椎间盘突出、椎体后缘骨刺、增生后缘骨刺、增生关节增生、后纵韧带骨化、黄韧带肥大或钙化,导致脊髓受压或脊髓缺血和脊髓功能障碍的一种颈椎病[1-2]。然而,脊髓型颈椎病的最佳手术策略仍然是有争议的。前路、后路和联合前后路减压的术式选择主要取决于颈椎矢状位、脊髓压迫的位置和疾病的严重程度[3]。一般来说,除了多节段的颈椎压迫外,大多数脊柱外科医生都选择颈前路手术,其包括颈前路椎间盘切除椎间融合术(anterior cervical discectomy and fusion, ACDF)和颈前路椎体次全切除椎间融合术(anterior cervical corpectomy and fusion, ACCF)。这两种术式目前已经被认为是治疗脊髓型颈椎病的标准术式[4]。

在颈椎前路手术中,当患者有较长的病史、明显的退变、椎体后缘大骨赘形成(如颈椎后纵韧带骨化症)时,这类患者往往同时存在椎间隙狭窄,如果进行 ACDF 手术,狭窄的手术空间将增加手术的难度和手术相关的风险,即使进行潜行减压,也往往难以实现完全减压。这类患者往往采用 ACCF 术式,其减压范围更为广泛,植骨融合率更高[5]。对于双节段脊髓型颈椎病的前路手术方式的选择仍有争议。临床治疗中,术者考虑 ACDF 术式可能无法彻底减压时则行 ACCF 术,但同时也带来一定的问题,如术后颈椎生理曲度变直,钛网沉降等[6]。术后矢状位参数可预测患者预后和生活质量。同时,矢状面的不平衡也是导致预后差的重要因素[7-8]。在颈椎矢状位排列参数中,许多研究强调 T_1 斜率、$C_{2\sim7}$矢状位纵轴距和 $C_{2\sim7}$前凸角对患者的预后有积极影响[9]。本研究回顾性分析接受 ACDF 和 ACCF 术的双节段脊髓型颈椎病患者的围手术期数据、临床参数和影像学数据,以评价这两种手术方式对治疗双节段脊髓型颈椎病的有效性。

1　资料与方法

1.1　一般资料　回顾性分析 2020 年 1 月至 2022 年 12 月南通大学杏林学院附属南京江北医院收治的 58 例双节段脊髓型颈椎病患者的临床资料。按手术方式分为 ACDF 组 30 例和 ACCF 组 28 例。两组患者术前一般资料比较差异无统计学意义($P>0.05$)。见表 1。

表 1　两组患者一般资料比较

Tab. 1　Comparison of general information between two groups

项目	ACDF 组 ($n=30$)	ACCF 组 ($n=28$)	χ^2/t 值	P 值
性别(男/女,例)	17/13	15/13	0.056	0.813
年龄(岁, $\bar{x}\pm s$)	58.71±7.53	61.15±8.69	1.674	0.260
病程(月, $\bar{x}\pm s$)	11.71±3.53	10.23±2.53	2.007	0.071
手术节段(例)				
$C_{3\sim5}$	7	6		
$C_{4\sim6}$	15	14	0.043	0.979
$C_{5\sim7}$	8	8		
随访时间(月, $\bar{x}\pm s$)	14.78±5.46	16.24±7.41	1.410	0.164

1.2　纳入与排除标准　纳入标准:无凝血功能障碍;经 X 线、CT 和 MRI 确诊为脊髓型颈椎病,影像学检查显示两个相邻节段脊髓受到突出的椎间盘、椎体后缘增生骨赘和轻微的后纵韧带骨化压迫,保守治疗 3 个月无效,行 ACDF 或 ACCF 术的患者。排除标准:创伤引起颈部脊髓受压患者;颈椎椎体畸形发育者、肿瘤、颈椎感染、严重颈椎后纵韧带骨化患者;合并严重的骨质疏松者;无法耐受手术或有手术禁忌证;术后失访或其他因素死亡。

1.3　手术方法　全身麻醉成功后,患者取仰卧位,颈部过伸位,于右颈部做横形切口,长约 5 cm,切开颈阔肌,钝性分离颈动脉鞘和内脏间隔,显露责任椎间隙,C 臂机透视下定位针定位,于责任节段上、下椎体内置入撑开螺钉,放置椎间撑开器,椎间适度撑开。(1) ACDF 组:首先切除上一椎间隙的颈椎椎间盘,处理上下软骨终板,刮匙刮除椎体后缘骨赘,增生骨赘较硬时采用高速磨钻打磨后再次使用刮匙,切除增生肥厚的后纵韧带,探查硬膜囊膨隆良好,椎管减压彻底。测量责任椎间隙高度,试模后选择合适大小的 ROI-C 椎间融合器,融合器内植入术中切除的碎骨,去除椎间撑开器及撑开钉,安置锁定嵌片(钛合金)

（法国 LDR 公司），同法再次处理下椎间隙。（2）ACCF组：首先摘除病变的两节段椎间盘，切除责任椎体，勾刀切开后纵韧带，咬除椎体后缘骨赘，小心切除增生肥厚的后纵韧带，选取合适长度椎体支撑体（四川国纳科技有限公司），将减压过程中切除的碎骨填入支撑体后置入骨槽，撑开恢复颈椎高度，以颈前路钢板固定。两组术式内固定后均留置 1 根切口引流管，充分止血后逐层缝合。两种手术均由同一名资深脊柱外科主任医师完成。

所有患者术后预防性使用抗生素 24 h，予营养神经、镇痛等对症治疗，卧床期间行双下肢肢体气压治疗，术后 48 h 内拔除引流管，协助患者佩戴颈托后下地行走，康复科指导患者加强四肢功能锻炼，嘱咐患者术后佩戴颈托固定 1.5 个月。

1.4　观察指标与影像学参数测量　围手术期数据与临床评分：住院时间、术中出血量和手术时间、颈部残疾指数评分（neck disability index, NDI）、疼痛视觉模拟评分（visual analogue scale, VAS）。

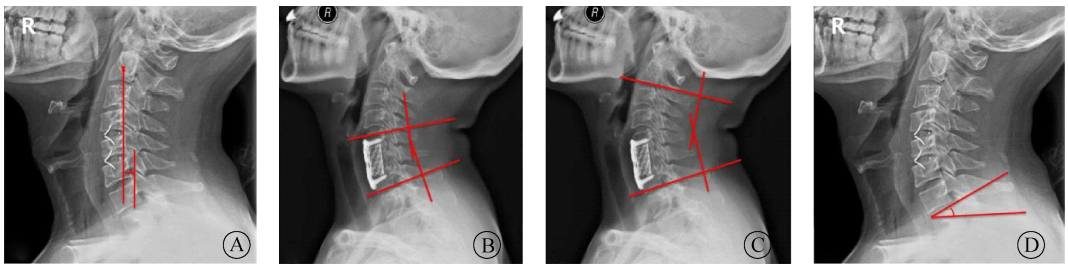
影像学参数（图 1）：节段角（在颈椎侧位 X 线片上，由两条平行于手术节段上、下两个椎体上、下终板的线所产生的角度）、T_1 斜率（水平线与 T_1 上端板之间的夹角）、$C_{2\sim7}$矢状位纵轴距（从 C_2 中心的铅垂线到 C_7 的后上角的铅垂线之间的距离）、$C_{2\sim7}$前凸角（C_2 和 C_7 下终板平行线的夹角）和融合率［最后一次随访时（≥6 个月），根据 Bridwell-Lenke 分级，在侧位片上对椎间体融合进行评分，1 级被认为是椎间融合，终板变得模糊，骨小梁连续性和骨桥接在椎间隙中可以观察到］。

1.5　统计学方法　采用 SPSS 20.0 软件处理数据。计量数据以 $\bar{x}\pm s$ 表示，组间比较采用独立样本 t 检验。性别、手术节段以例表示，采用 χ^2 检验和校正 χ^2 检验。$P<0.05$ 为差异有统计学意义。

2　结　果

2.1　围手术期数据与临床评分情况　在围手术期方面，ACDF 组的手术时间、术中出血量低于 ACCF 组（$P<0.05$）。两组的术后 NDI 评分及 VAS 评分均低于术前（$P<0.05$），但两组差异无统计学意义（$P>0.05$）。见表 2。

2.2　影像学参数　ACDF 组术后、末次随访的节段角及 $C_{2\sim7}$前凸角均较术前显著改善，且大于 ACCF 组（$P<0.05$）。两组 T_1 斜率、$C_{2\sim7}$矢状位纵轴距、融合率差异无统计学意义（$P>0.05$）。见表 3。



注：A，$C_{2\sim7}$矢状位纵轴距（从 C_2 中心的铅垂线到 C_7 的后上角的铅垂线之间的距离）；B，节段角（在颈椎侧位 X 线片上，由两条平行于手术节段体上、下两个椎体上、下终板的线所产生的角度）；C，$C_{2\sim7}$前凸角（C_2 和 C_7 下终板平行线的夹角）；D，T_1 斜率（水平线与 T_1 上端板之间的夹角）。

图 1　影像学参数

Fig. 1　Imaging parameters

表 2　两组围手术期数据与临床评分比较　（$\bar{x}\pm s$）

Tab. 2　Comparison of perioperative data and clinical scores between two groups　（$\bar{x}\pm s$）

组别	例数	手术时间（min）	术中出血量（mL）	住院时间（d）	NDI 评分（分）		VAS 评分（分）	
					术前	术后	术前	术后
ACDF 组	30	107.38±12.29	58.36±24.31	7.31±1.76	13.41±2.76	11.14±4.32[a]	5.31±1.41	2.31±1.08[a]
ACCF 组	28	118.37±11.36	77.73±27.51	6.59±1.34	13.16±1.31	11.48±3.89[a]	6.11±2.16	2.31±1.36[a]
t 值		3.529	2.846	1.760	0.445	0.315	1.681	0.000
P 值		<0.001	0.006	0.084	0.666	0.755	0.098	1.000

注：与术前比较，[a]$P<0.05$。

表 3　两组患者影像学参数比较　($\bar{x}\pm s$)

Tab. 3　Comparison of imaging parameters between two groups of patients　($\bar{x}\pm s$)

组别	例数	节段角(°)			T_1 斜率(°)		
		术前	术后	末次随访	术前	术后	末次随访
ACDF 组	30	6.36±3.31	9.73±2.41[a]	8.24±3.31[a]	28.15±8.82	29.48±7.39	29.17±9.38
ACCF 组	28	5.71±2.86	6.01±3.34	5.31±2.73	27.41±7.76	26.54±8.31	26.24±6.32
t/χ^2 值		0.802	4.841	3.663	0.340	1.420	1.385
P 值		0.426	<0.001	<0.001	0.735	0.160	0.172

组别	例数	$C_{2\sim7}$矢状位纵轴距(mm)			$C_{2\sim7}$前凸角(°)			融合率(%)
		术前	术后	末次随访	术前	术后	末次随访	
ACDF 组	30	2.36±1.33	2.73±1.01	2.45±1.41	14.35±5.51	19.63±6.61[a]	18.78±5.81[a]	93.3
ACCF 组	28	1.91±1.06	2.19±1.14	2.11±1.09	13.31±4.78	14.59±4.34	14.11±3.54	96.4
t/χ^2 值		1.430	1.904	1.031	0.769	3.454	3.724	0.004
P 值		0.162	0.062	0.307	0.445	0.001	0.001	0.951

注:与术前比较,[a]P<0.05。

3　讨　论

脊髓型颈椎病的相应临床表现主要是由于椎间盘突出、受累椎体及关节突退变、后纵韧带骨赘形成等造成脊髓受压所引起。临床上颈前路手术(ACDF 和 ACCF 术式)可有效地缓解患者神经压迫症状和矫正颈椎后凸畸形的问题[10]。对于轻中度颈椎间盘突出或退变引起的脊髓型颈椎病,伴或不伴颈椎后凸,大多采用 ACDF 术式,其创伤小、出血少,可以直接去除椎管前方致压物,减压效果良好;同时可以一定程度上恢复颈椎生理曲度,为神经脊髓的功能恢复创造条件。但该术式术中视野范围小,操作空间有限,对于较大骨赘难以完全去除[11]。对于椎管前方压迫组织来自于椎体后缘增生的骨赘、钙化的后纵韧带和巨大椎间盘突出等,ACDF 术难以做到完全减压,ACCF 术通过颈椎椎体次全切除,可以在较好的视野条件下充分减压,广泛清除椎体后缘的致压物[12]。但该术式因破坏了椎体的前中柱,容易造成固定钛板移位松动失效,植入钛网沉降,颈椎生理弧度减小甚至反向畸形等[13]。

本研究发现,对于双节段脊髓型颈椎病,ACDF 和 ACCF 术式均能取得满意的临床结果和融合率,两组患者 NDI 评分和 VAS 评分显著下降。而在手术时间和术中出血量方面,ACDF 要优于 ACCF 术式。这一结果说明 ACDF 术式的手术创伤更小,有利于患者的术后快速康复。

关于颈椎矢状参数,Lee 等[14]研究发现术后 $C_{2\sim7}$ 矢状位纵轴距与患者生活质量密切相关,包括 NDI 评分和 JOA 评分。此外,据报道,T_1 斜率可作为评价矢状面平衡、预测生理序列和指导手术方案的指标。T_1 斜率可影响颈椎的弯曲度,以确保头部的重心处于平衡位置[15]。之前研究报道指出,手术干预维持 $C_{2\sim7}$ 节段前凸角对患者的预后有积极影响。总之,在颈椎矢状参数中,T_1 斜率、$C_{2\sim7}$ 矢状位纵轴距和 $C_{2\sim7}$ 节段前凸角具有重要作用。在本研究中,T_1 斜率和 $C_{2\sim7}$ 矢状位纵轴距均没有显著改善。而在 ACDF 组中,手术节段角和 $C_{2\sim7}$ 节段前凸角的维持优于 ACCF 组。生理曲度的恢复是维持颈椎正常生物力学的基础,曲度的恢复可以间接地恢复椎管的体积,从而间接地进行脊髓减压。颈椎生理曲度的维持可以防止术后轴性疼痛和邻近节段退行性改变的发生。虽然 ACCF 具有操作空间大、减压充分的优点,但它对前柱结构造成了更多的损伤,使植骨比椎间植骨更困难。如果减压范围长,无论取髂骨或长钛网用于植骨,均存在应力改变导致植骨移位的风险。然而,手术的选择取决于颈椎脊髓压迫的特点。对于颈椎椎体后纵韧带骨化、椎管内突出物较大或钙化的患者,通常首选 ACCF 术式。显微技术的发展使得 ACDF 的适应证变得更广泛。因此,在大多数情况下,对于相邻两节段脊髓型颈椎病的患者,ACDF 术式作为外科治疗的一种值得选择的方法。

利益冲突　无

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收稿日期:2024-01-02　**修回日期**:2024-01-25　**编辑**:李方

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收稿日期:2024-01-03　**修回日期**:2024-02-11　**编辑**:王宇