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Posterior or Single-stage Combined Anterior and Posterior Approach Decompression for Treating Complex Cervical Spondylotic Myelopathy Coincident Multilevel Anterior and Posterior Compression

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Study Design: A single-center, retrospective, longitudinal matched cohort clinical study of prospectively collected outcomes.

Objective: To compare retrospectively the clinical outcomes and complications of the posterior approach laminoplasty and single-stage anterior approach laminoplasty combined with anterior cervical corpectomy and fusion and anterior cervical discectomy and fusion for treating patients with cervical spondylotic myelopathy coincident multilevel anterior and posterior compression, known as complex cervical spondylotic myelopathy (cCSM) here.

Summary of Background Data: The optimal surgical management of this type of cCSM remains controversial.

Methods: Sixty-seven patients with multilevel cCSM underwent decompression surgery from 1996 to 2007. Among these patients, 31 underwent a single-stage combined approach with decompression (combined approach group) and 36 underwent laminoplasty for posterior approach (posterior approach group). Average operative duration, operative estimated blood loss, surgical costs, and cervical alignment were measured.

Results: Average operative duration, operative estimated blood loss, and surgical costs were significantly lower in the posterior approach group than those in the combined approach group ($P < 0.001$). Visual analog scale and modified Japanese Orthopedic Association scale were insignificantly different at each data collection period ($P > 0.05$). No statistical difference was observed in the preoperative Cobb angle ($P > 0.05$), whereas a significant statistical difference was observed for the postoperative Cobb angle ($P < 0.05$) and variation of Cobb angle ($P < 0.05$) between the 2 groups. The surgical incidences of complications were 22.2% and 48.4% in the posterior and combined approach groups ($P < 0.05$), respectively.

Conclusions: For treating multilevel cCSM, both the posterior approach laminoplasty and single-stage combined approach led to significant neurological improvement and pain reduction in the majority of patients. Both approaches showed similar results in terms of decompression and neurological improvement. The posterior approach was superior to the combined approach in terms of surgical costs, surgical time, blood loss, and complication rate.

Key Words: combined approach, posterior approach, laminoplasty, complex cervical spondylotic myelopathy (cCSM)

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Cervical spondylotic myelopathy (CSM) is a common spinal disease caused by the narrowing of the cervical spinal canal as a result of degenerative and congenital changes, and leads to significant neurological disability.[1] Some patients with complex CSM suffer anterior and posterior spinal cord compressions. The compressed spinal cord, which is thinner than 50% of the anteroposterior diameter of the compressed cervical spinal canal, is clinically known as "pinching" CSM in China.[2] In most of these patients, such compressions simultaneously occur with congenital or developmental cervical stenosis and usually multilevel (≥ 3 levels) clinically, known as complex cervical spondylotic myelopathy (cCSM) here. The diagnosis of cCSM is mainly based on the imageological examination from cervical magnetic resonance imaging (MRI). One of the clinical features of cCSM is mild cervical trauma, which often results in severe acute cervical spinal cord injury. Moreover, once

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clinical symptoms appear, they usually progress rapidly in a short time. Thus, cCSM theoretically requires earlier operation than normal CSM.

Different alternative surgical strategies have been proposed and encouraged for the treatment of CSM. Anterior approach with decompression, such as anterior cervical corpectomy and fusion (ACCF) and anterior cervical discectomy and fusion (ACDF), can be used to resect the disk material and posterior osteophytes impinging on the spinal cord at the level of the disk space or immediately adjacent to the level of such space.[3] However, the effect of the anterior approach may be limited, and the procedure may result in inadequate decompression with a single-ventral surgery.[4] Theoretically, the anterior approach alone fails to eliminate dorsal compression because cervical lordosis limits the forward shift of the spinal cord. Anterior interbody grafting beyond 2 levels is associated with an increased rate of pseudarthrosis.[5] Moreover, multilevel discectomy and corpectomy may cause instability[6] and increase the occurrence of complications.[7] Thus, this approach alone may theoretically be unsuitable for treating multilevel cCSM, when its compressions are multilevel, both from dorsal and ventral regions.

Posterior procedures, such as laminoplasty and laminectomy, can expand the canal in posterior directions and provide space for the spinal cord to retract and obtain decompression. Laminectomy has been regarded as the standard posterior procedure for treating CSM and is associated with significant segmental instability, kyphosis, perineural adhesions, and late neurological deterioration.[8–10] Meanwhile, laminoplasty is the preferred method for treating multisegmental CSM when neurological results, incidence of complications, and postoperative treatment are considered in the absence of preoperative kyphosis.[11,12]

The combined approach, such as laminoplasty or laminectomy combined with ACCF[13] and ACDF,[14] can be used to resect both the ventral and dorsal compressions of the thecal sac directly and expand the canal in the anterior and posterior directions for adequate decompression. Hence, this approach may theoretically be the ideal method for treating multilevel cCSM. However, the combined approach may increase the probability of spinal cord injury because the patient needs to be turned over during the single-stage operation.[15,16] In addition, this approach requires surgeons with relatively high skill level. Moreover, as an anterior approach, the combined approach has the disadvantages of pseudarthrosis,[5] instability,[6] and increased occurrence of complications.[7]

In most cases of surgical procedures for single-level or 2-level cCSM (< 3 levels), ACCF and ACDF anterior approaches have been consistently reported to be safe and effective. However, the cCSM usually occurs with >3 levels (≥3 levels) clinically. Moreover, cCSM is usually concomitant with developmental spinal stenosis and degenerative spinal stenosis in China.[17] Considering that no standards or guidelines exist for treating multilevel cCSM, the surgical choice of an anterior, posterior, or combined approach for multilevel cCSM is traditionally based on the location and extent of compressive pathology.[18] If the chosen approach is less efficient or clinical symptoms exacerbate after several months or years, then a remedial 2-stage contralateral operation can be performed.[15]

Previous studies found that the 1-stage combined approach has a better neurofunctional improvement in treating multilevel cCSM.[16,19,20] In addition, this approach has a faster and better neurofunctional improvement and lower cost, as well as causes less pain as compared with the 2-stage combined approach.[15] Other studies demonstrated that laminoplasty is effective in relieving symptoms and a safe method for decompressing the spinal canal and nerve roots in patients with multilevel cCSM.[16,21]

However, whether the single-stage combined approach has better clinical effects than the posterior approach, or vice versa, remains unknown. To compare the clinical effects of the 1-stage combined approach with those of the posterior approach with decompression in patients with multilevel cCSM, we analyzed 67 multilevel cCSM cases by a single-center, retrospective, longitudinal matched cohort study of prospectively collected outcomes.

MATERIALS AND METHODS

Patients Population

Sixty-seven consecutive patients underwent decompression surgery for multilevel cCSM in the Spineosurgery Department of The First Affiliated Hospital of Luohe Medical College from 1996 to 2007. Among these patients, 31 were treated using the single-stage combined approach (laminoplasty combined with ACCF and ACDF) with decompression (combined approach group), whereas 36 were subjected to open-door laminoplasty as the posterior approach (posterior approach group). The inclusion criteria for this study were as follows. The patients with CSM were diagnosed as multilevel cCSM based on cervical MRI, which showed multilevel (≥3 levels) anterior and posterior spinal cord compressions and extent of compression reaching ≥50% of the spinal canal. According to the aims of this study, patients with single-level or 2-level cCSM (< 3 levels) who fail to meet the inclusion criteria of multilevel cCSM and those who had a previous history of cervical spine surgery were excluded. On the basis of our past experience, fixed kyphotic spines were not considered for stand-alone laminoplasty because of the possibility of insufficient spinal recession. Radiologic examinations included plain radiography, computed tomography (CT), and MRI. Compressive mass characteristics were evaluated using CT and MRI.

Approval from the Institutional Review Board was obtained. Patient outcomes were initially collected independently from patients with informed consent and then analyzed blindly to avoid influencing the outcome scores.

Surgical Technique

Patients in the posterior approach group underwent open-door laminoplasty, according to a modified meth-

FIGURE 1. Schematic showing methods by which to measure Cobb's angle. The overall cervical (C2–C7) alignment was measured by Cobb's method through the inferior endplates of C2 and C7 with a mid sagittal T2-weighted image of MRI.

od.[22] The vertebral lamina was lifted for approximately 8–12 mm intra-operatively, and the nerve root canal was expanded up to 2–5 mm at the opened segment to ensure the flexibility of the nerve root.[23] After the open-door laminoplasty, the patients in the combined approach group were turned over, and ACCF and ACDF were conducted. The intervertebral disk, subtotal vertebral body, and osteophytes at diseased segments were removed for spinal canal decompression. Autologous iliac crest or allogenic bone (Shanghai Anjiu Biotechnology Co., Ltd., Shanghai, China) was implanted into the gap, followed by fixation with an anterior titanium plate (Suzhou Kangli Orthopaedics Instrument Co. Ltd, Lianyungang, Jiangsu, China).

Outcome Measures

Admission, hospital, and clinical follow-up records were retrospectively reviewed for each patient. Extracted data included age, sex, levels involved, operative duration (min), operative estimated blood loss (mL), and surgical cost (¥) when they were discharged. Pain and functional disability were quantitatively measured using the visual analog scale (VAS) and the modified Japanese Orthopedic Association (mJOA) scale.[24] Both scales were used to measure at 3, 6, and 12 months and at the final follow-up after surgery. The average surgical cost refers to the total cost during hospitalization, excluding the costs of rehabilitation after discharge. The average costs in yuan (¥) were converted into average costs in dollars ($), according to the exchange rate at the time of the last follow-up (¥/$ = 7/1).

We found that not all of the lateral cervical spine radiographs can clearly display the C7 vertebra or its inferior margin for all patients. Modified Cobb angles (α) from C2 to C7 (Fig. 2) were measured and analyzed preoperation and postoperation to ascertain overall cervical alignment[25] (ie, the sagittal T1- or T2-weighted image of MRI for the measurement of the Cobb angles of overall cervical alignment in its mid sagittal image was used). Cobb angles were measured using a measurement analysis software (Image-Pro Plus; Media Cybernetics Inc.), and the intersecting angle between 2 lines drawn were measured (Fig. 1). In C2–C7 alignment, curvatures were defined as follows: kyphosis, Cobb angle: < 0; straight, $0 \leq$ Cobb angle: < 5; lordosis, Cobb angle: ≥ 5.[25]

Statistical Analysis

SPSS software (version 11.5) was used for statistical analysis. Data are presented as mean ± SD. The VAS and mJOA scales, age, operative duration, estimated blood loss, surgical costs, and cervical alignment were analyzed using an independent sample *t* test, whereas sex, number of levels, and incidence of complications were evaluated by χ^2 test. *P*-values < 0.05 were considered statistically significant.

RESULTS

Patient ages ranged from 23 to 80 years. All patients underwent follow-up for 18 months to 8 years (with an average of 38.4 mo). Significant differences were not detected between the 2 groups in terms of sex, age, and levels involved (Table 1).

Operative Data

Postoperative MRI of the 2 groups indicated satisfactory decompression with reduced intramedullary signals. The results also revealed evident spinal cord recession, which indicated relief from anterior and posterior compressions and unobstructed flow of cerebrospinal fluid. The anterior intervertebral disk herniation apparently disappeared or was reduced (Fig. 2). CT results showed a fully expanded spinal canal.

The mean VAS scores for each data collection period were used to evaluate pain improvement. The postoperative VAS scores of the patients in the posterior approach group decreased from an average of 4.0 ± 1.0 to 1.8 ± 0.5 points in the baseline. The postoperative mJOA scores of the patients in the combined approach group decreased from an average of 4.0 ± 1.1 to 1.7 ± 0.5 points in the baseline. Significant differences were not observed between the 2 groups from the baseline before surgery to the last follow-up after surgery ($P > 0.05$; Table 2).

The mJOA scores for each data collection period were used to evaluate neurofunctional improvement. The postoperative mJOA scores of the patients in the posterior approach group increased from an average of 7.8 ± 1.0 to 14.4 ± 1.3 points in the baseline. The postoperative mJOA scores of the patients in the combined approach group increased from an average of 8.0 ± 0.9 to 14.5 ± 1.2 points in the baseline. No statistical difference was observed in the mJOA scale score for neurofunctional improvement between the 2 groups ($P > 0.05$; Table 2).

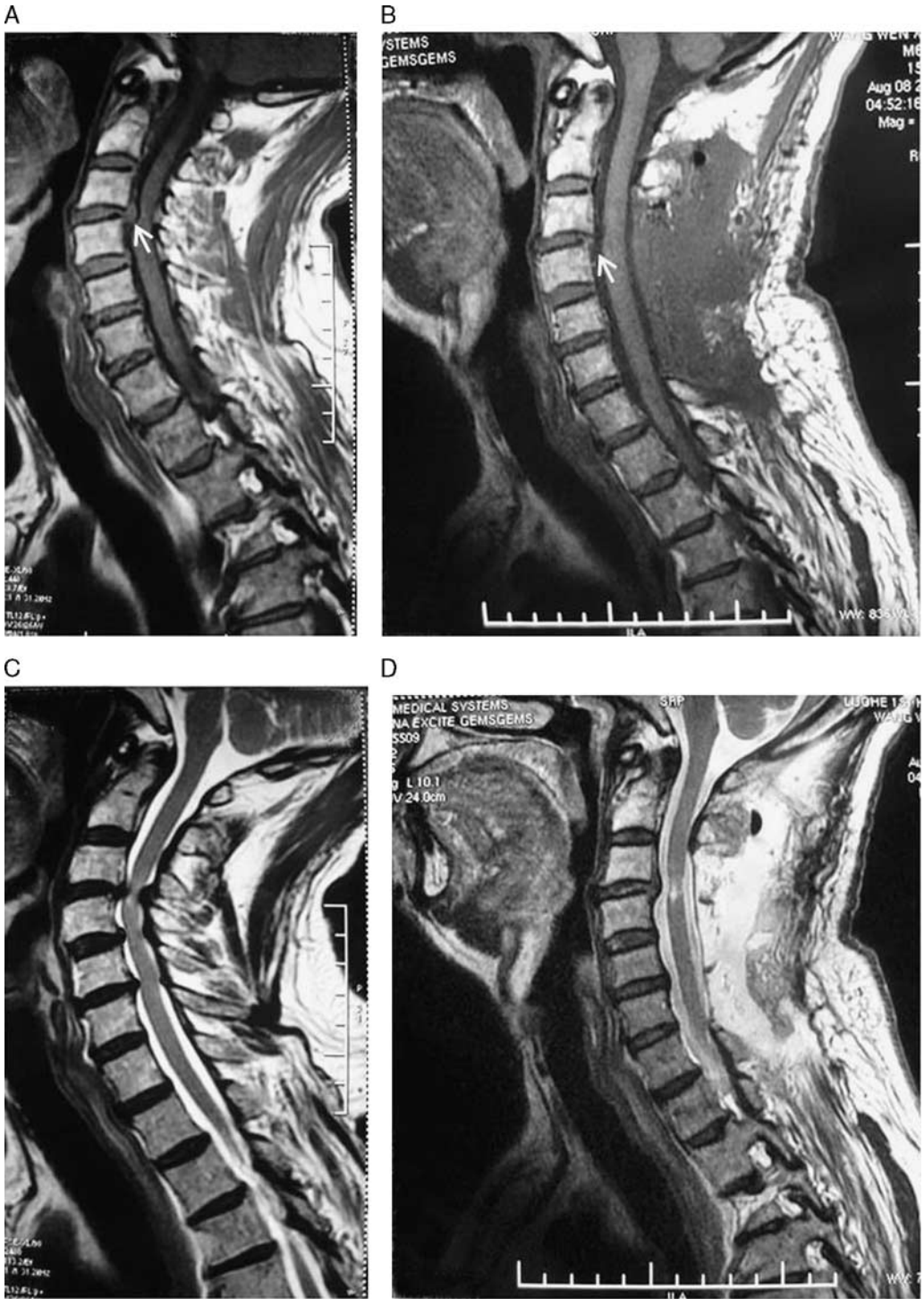

FIGURE 2. Preoperative duration sagittal T1-weighted image showing soft-compression pathologies. (A) Apparent reduction compared with postoperative results, and (B) at 6 months after open-door laminoplasty. Arrows point to the soft-compression pathologies. Preoperative sagittal T2-weighted image showing spinal stenosis and multilevel soft compression (C4/C5–C6/C7) with intramedullary signal changes; the compressed spinal cord was locally thinner than 50% of the anteroposterior diameter of the cervical spinal canal (C). Postoperative sagittal T2-weighted image showing adequate decompression with reduced intramedullary signal (D).

TABLE 1. Summary of the Main Demographic Data

Basic Characteristics and Surgical Data	Posterior Group (Range)	Combined Group (Range)	*P*
Total patients	36	31	
Male/female	28/8	18/13	0.083
No. levels			
3	28	22	0.760
4	6	6	
5	2	3	
Mean age (y)	56.0 ± 7.9 (23.0–73.0)	59.3 ± 11.4 (32.0–77.0)	0.162
OP duration (min)	72.0 ± 8.9 (61.0–100.0)	216.03 ± 33.21 (160.0–278.0)	< 0.001
OP EBL (mL)	370.0 ± 24.0 (321.0–404.0)	710.0 ± 41.8 (639.0–792.0)	< 0.001
Surgical cost ($)	1340.5 ± 89.6 (1189.6–1485.9)	4267.4 ± 1103.3 (2814.4–7098.9)	< 0.001

Values (age, OP duration, OP EBL, and surgical cost) are expressed as mean ± SD.
Differences are considered significant at $P < 0.05$.
¥/$ = 7/1.
EBL indicates estimated blood loss; OP, operative.

Changes in the overall cervical alignment showed that in the posterior approach group, the C2–C7 Cobb angle decreased from an average of 17.6 ± 6.1 to 14.4 ± 5.9 (preoperative to postoperative). In the combined approach group, the angle decreased from an average of 16.5 ± 11.1 to 9.4 ± 6.9 (preoperative to postoperative). No statistical difference was observed in the preoperative Cobb angle between the 2 groups ($P > 0.05$), whereas a significant statistical difference was observed for the postoperative Cobb angle ($P < 0.05$) and variation of Cobb angle ($P < 0.05$) between the 2 groups (Table 3).

Complications

As the description in Table 4, incidences of esophageal or tracheal ruptures were not detected, and cases of C5 nerve root palsy and death were not observed in this series. Surgical complications were observed in 23 patients: 22.2% (8 of 36 patients) in the posterior approach group and 48.4% (15 of 31 patients) in the combined approach group ($P < 0.05$). For the posterior approach group, cerebrospinal fluid leakage was observed in 2 cases. One patient complained of a transient radiating pain in the shoulder, but recovered 1 week after the operation. Three patients complained of axial neck pain, which gradually subsided in 1–3 months with occasional nonsteroidal anti-inflammatory drug medication. For the combined approach group, cerebral fluid leakage was noted in 4 cases (Fig. 3). One patient exhibited neurological deterioration caused by extradural hematoma 4 hours after surgery, but the patient gradually recovered upon the removal of the hematoma. Transient recurrent laryngeal nerve palsy was observed in 3 patients, but no further treatment was given to these patients. Two patients complained of axial neck pain, which gradually subsided in 1–3 months with occasional nonsteroidal anti-inflammatory drug medication. Two patients had superficial infections, but they recovered 2 weeks after the operation. One patient failed to achieve postoperative fusion at 12 months and underwent another operation. The operation was performed using the 2-stage posterior approach stabilization, with autologous iliac crest implantation and internal fixation to stabilize the

TABLE 2. Clinical Outcomes in Both Groups According to Visual Analog Scale (VAS) and Modified Japanese Orthopedic Association Scale (mJOA) Scores

Basic Clinical Scores	Posterior Group (Range)	Combined Group (Range)	*P*
VAS score			
Baseline VAS score	4.0 ± 1.0 (2–7)	4.0 ± 1.1 (3–7)	0.987
Postoperative			
3 mo	2.4 ± 0.6 (2–4)	2.2 ± 0.7 (1–5)	0.149
6 mo	1.7 ± 0.6 (1–3)	1.7 ± 0.4 (1–2)	0.883
12 mo	1.6 ± 0.5 (1–2)	1.6 ± 0.5 (1–2)	0.632
Last follow-up	1.8 ± 0.5 (1–3)	1.7 ± 0.5 (1–3)	0.770
mJOA scale score			
Baseline mJOA score	7.8 ± 1.0 (6.0–11.0)	8.0 ± 0.9 (6.0–10.0)	0.419
Postoperative			
3 mo	12.1 ± 1.8 (9.0–15.0)	12.2 ± 1.5 (10.0–16.0)	0.779
6 mo	12.9 ± 1.5 (9.0–16.0)	13.3 ± 1.3 (11.0–16.0)	0.286
12 mo	14.0 ± 1.5 (10.0–17.0)	13.8 ± 1.0 (12.0–15.0)	0.564
Last follow-up	14.4 ± 1.3 (13.0–17.0)	14.5 ± 1.2 (12.0–16.0)	0.906

All values are expressed as mean ± SD.
Differences are considered significant at $P < 0.05$.

TABLE 3. Changes in the Overall Cervical Alignment (C2–C7 Cobb Angle) Preoperation and Postoperation

Cobb Angle	Posterior Group (Range)	Combined Group (Range)	*P*
Preoperative Cobb angle (deg.)	17.6 ± 6.1	16.5 ± 11.1	0.620
Postoperative Cobb angle (deg.)	14.4 ± 5.9	9.4 ± 6.9	0.002
Variation of Cobb angle (deg.)	4.8 ± 3.8	11.3 ± 9.4	0.001

All values are expressed as mean ± SD.
Differences are considered significant at $P < 0.05$.

cervical spine and achieve fusion at 12 months postoperation.

DISCUSSION

In this study, the spinal cord of patients with multilevel cCSM was evidently moved backward by increasing the opening degrees to achieve satisfactory neurological improvement after the operation. Such improvement was demonstrated by the increase and decrease in the mJOA and VAS scores (Table 2). With regard to surgical invasiveness, the 2 groups showed differences in terms of blood loss, operating time, surgical costs, and occurrence of complications. The posterior approach group showed lower blood loss, shorter operating time, and fewer incidences of complications than the combined approach group. These differences were attributed to the absence of a procedure for additional corpectomy and discectomy, bone graft, and instrumented fusion in the posterior approach. The reduced surgical costs in the posterior approach was attributed to the laminoplasty procedure. This procedure can be completed even without using an internal fixation instrument. A low-cost approach is particularly beneficial for patients in developing countries, such as China.

JOA score is not a direct criterion for evaluating decompression but has been used to assess the effectiveness of decompression.[20] No statistical difference was observed in the neurofunctional improvement between the 2 groups for each data collection period ($P > 0.05$; Table 2). This finding indicated the effectiveness of decompression in the posterior approach group and the combined approach group.

Historically, multilevel corpectomy and discectomy[22] and laminoplasty[23] have been regarded as the standard posterior procedure for treating multilevel cCSM. Considerable studies demonstrated that both corpectomy and laminoplasty reliably arrest myelopathic progression and can lead to significant neurological recovery and pain reduction in multilevel cCSM; no statistical differences were observed between their recovery rate and the final score. Meanwhile, laminoplasty requires less pain medication and has lower prevalence of complications.[12] Laminoplasty is the preferred choice for the treatment of multilevel CSM when neurological results, incidence of complications, and postoperative treatment are considered.[11]

Reference data about selection of surgical approaches for multilevel cCSM, as a complex and special-type CSM, are few. However, some clues can be drawn from the treatment of multilevel CSM. Different surgical strategies have been proposed and adopted for multilevel cCSM; anterior, posterior, and single-stage or 2-stage combined anterior and posterior surgical approaches for multilevel cCSM have all been performed.[15,16,19,20] However, the optimal surgical approach remains controversial.[26]

The combined approach has been increasingly adopted in spine surgeries for treating multilevel cCSM clinically; this approach demonstrates a better effect on neurofunctional improvement.[16,19,26] To the best of our knowledge, comparison between the effect of laminoplasty combined with ACCF and ACDF and posterior approach of laminoplasty on treating multilevel cCSM has not been reported. In the present study, open-door laminoplasty for the posterior approach provided therapeutic efficacy similar to that of the combined approach. Meanwhile, the posterior approach resulted in fewer complications, shorter operative time, lower blood loss, and lower surgical cost than the combined approach.

An interesting finding of this study was that some of the anterior soft-compression pathologies, such as the intervertebral disk herniation, shrank, reduced, and even disappeared to some extent (Fig. 2). However, large bony compression pathologies slightly changed during a prolonged follow-up period. The mechanism underlying this phenomenon remains unclear. Such condition could possibly be related to the realignment and the regained interbody stabilization of the spinal vertebrae (Fig. 4).

The oversized lordosis of some patients improved postoperation, which can be inferred from the change in the overall cervical alignment (C2–C7 Cobb angle) (preoperative and postoperative). Such condition could possibly be related to the realignment and regained interbody

TABLE 4. Surgical Complications of the Patients

Complications	Posterior Group	Combined Group
Cerebral fluid leakage	2	4
Hematoma	0	1
Posterior reoperation	2	2
Axial neck pain	3	2
Superficial infection	0	2
Laryngeal nerve palsy	0	3
Nonunion	0	1
Neurological deterioration	1	0
Incidence of complications [n/N (%)]	8/36 (22.2)	15/31 (48.4)*

*$P = 0.025$, combined group versus posterior group.
Differences are considered significant at $P < 0.05$.

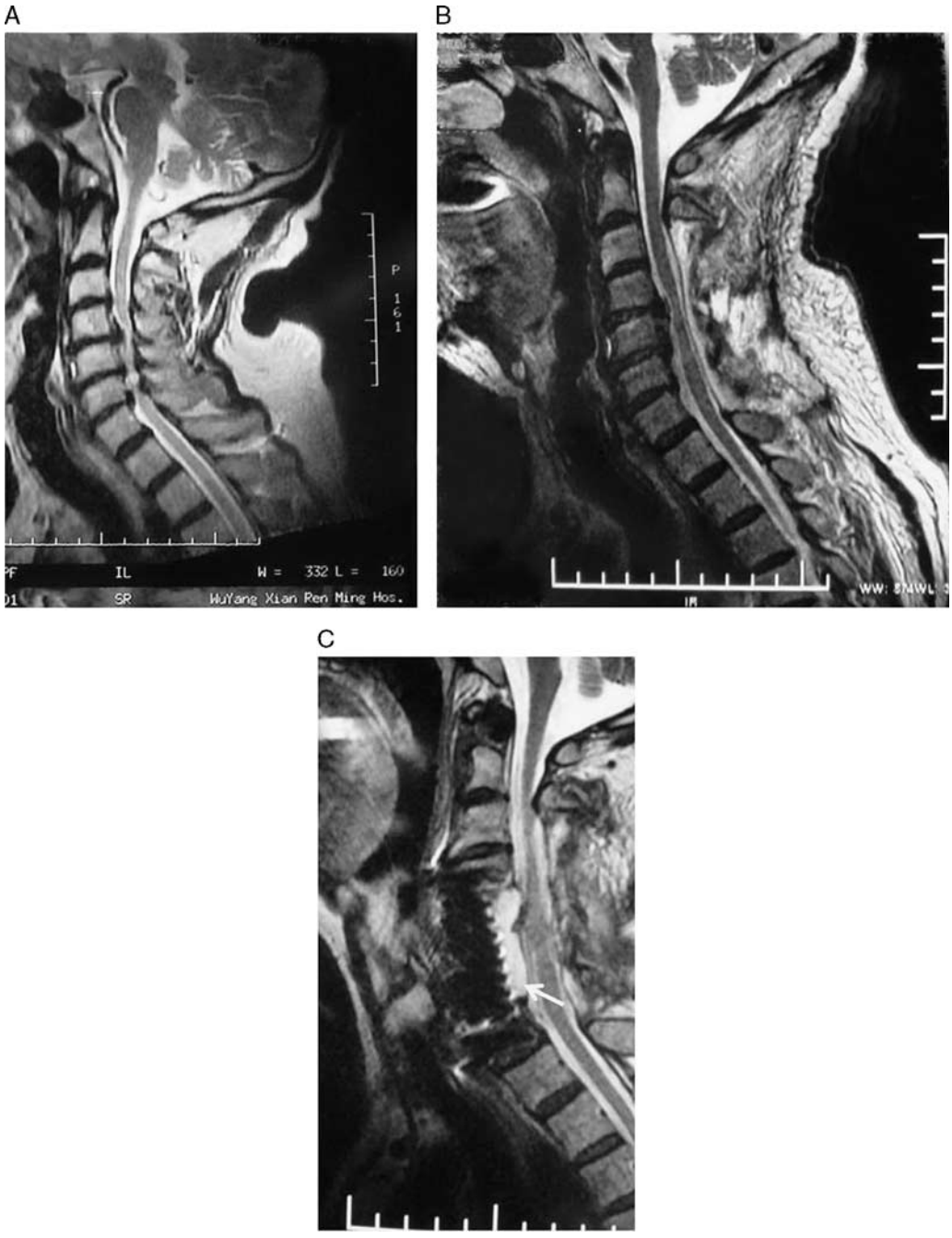

FIGURE 3. Preoperative duration sagittal T2-weighted image indicating multilevel bony compression pathologies (C3/C4–C6/C7) (A). After open-door laminoplasty for posterior approach, the spinal canal was apparently enlarged, and a posterior shift of the cord was observed. However, poor improvement of neurological function and bony compression pathologies were still evident (B). A 2-stage remedial anterior approach operation was performed 6 months after the first operation (C). Arrows point to the cerebral fluid leakage.

stabilization of the spinal vertebrae (Fig. 4), which in turn may have decreased the level of stress exerted on the spinal vertebrae, as well as the restoration of normal dural pulsation because of the unobstructed flow of cerebrospinal fluid. Thus, resection of the soft-compression pathologies may not necessarily be associated with a time-consuming and energy-consuming process that has lower costs. The spinal canal was accordingly enlarged by laminoplasty accompanied by spinal cord recession, followed by a reduction of a part of the soft-compression pathologies. Such

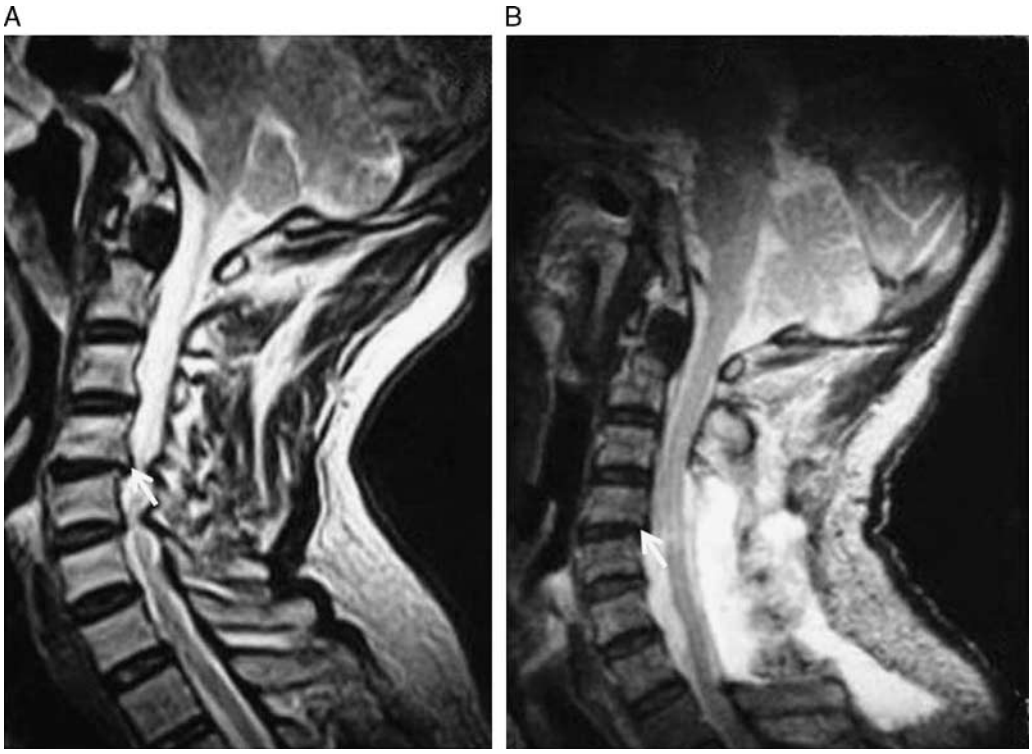

FIGURE 4. Preoperative duration sagittal T2-weighted image showing spinal stenosis and multilevel compression (C4/C5–C6/C7) with instability at C4/C5, the angle between C4/C5 was 18 degrees; the compressed spinal cord was locally thinner than 50% of the anteroposterior diameter of the cervical spinal canal (A). Sagittal T2-weighted image showing a completely decompressed spinal cord, the improved alignment of the cervical spine, and regained interbody stability at C4/C5 (B) after laminoplasty. Arrows point to C4/C5. Compression pathologies were apparently unstable (A) and reduced (B) at C4/C5.

enlargement of the spinal canal and decompression possibly caused the similarity of clinical outcomes between the 2 methods. Meanwhile, this condition also involves multiple factors of efficacy, such as the compression duration and levels of the spinal cord, the extent of surgical decompression, the age of patients, and the degree of spinal cord deterioration.

Thus, we classified the anterior compression pathologies as either soft or bony. Soft-compression pathologies may contain edematous intervertebral disks, venous plexus, hypertrophic ligaments, and other soft tissues. The anterior bony compression pathologies may contain osteophytes, calcified intervertebral disks, ossification of posterior longitudinal ligaments, and hyperplastic facets. This classification was one of our bases for selecting either the posterior approach or combined approach in treating patients with multilevel cCSM. Notably, the classification of compression pathology is frequently used in clinics by spinal surgeons in treating CSM. To the best of our knowledge, this study is the first to report these imageological findings. However, more prospective studies are needed for verification, and certain conclusions could not be drawn based on our limited cases.

The surgical management of patients with multilevel cCSM requires a comprehensive and individualized approach. Designing the most effective surgical plan depends on numerous factors. The indications for a surgical approach for multilevel cCSM should be modified according to the extent and location of the disease, spinal alignment (lordotic or kyphotic spine, stable or unstable spine), levels of congenital canal stenosis (1 level, 2 levels, or multiple levels), symptoms (with or without axial neck pain), and medical comorbidity, with special consideration of the particularities of compressive pathology (ventral, dorsal, or both; soft or bony), as well as the experience and preference of surgeon for specific procedures.[27]

Several limitations of our study should be noted. The retrospective nature of this study, being monocentric, heterogeneity of inclusion of patients, lack of randomization, present the possibility of selection bias, and these factors may have affected the present research results.

In summary, for multilevel cCSM, the current authors used either the posterior approach of laminoplasty or a single-stage combined approach (laminoplasty combined with ACCF and ACDF). These methods could reliably arrest myelopathic progression in multilevel cCSM. Both procedures resulted in significant neurological improvement and pain reduction. These procedures also showed similar results in terms of decompression and neurological improvement. However, the posterior approach was superior

to the single-stage combined approach in terms of surgical costs, surgical time, blood loss, and rate of complication. The laminoplasty may be a better candidate for treating multilevel cCSM and need to be explored. The classification of the anterior oppressing bodies into soft and bony compressions may aid in selecting the appropriate surgical approaches for patients with multilevel cCSM.

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