Surgical Management of Hourglass Cervical Spondylotic Myelopathy; Clinical and Functional Outcome

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ABSTRACT
Background: Both congenital and degenerative alterations can cause the cervical spinal canal to narrow in cervical spondylotic myelopathy (CSM), a common spine condition. This illness results in severe neurological impairment.
Objective: This study aimed to compare the clinical outcomes of two treatments in patients with hourglass cervical spondylotic myelopathy: Anterior cervical discectomy and fusion (ACDF) alone and one-stage combined ACDF and posterior cervical laminectomy (PCL) at the same level in a single procedure.
Patients and methods: Neurosurgery procedures at Menoufia University Hospital for cervical spondylotic myelopathy symptoms between 2017 and 2023. Group 1 consisted of 15 patients who underwent ACDF and PCL at the same level concurrently, while Group 2 consisted of 15 patients who underwent ACDF only. The combination strategy involved PCL and ACDF.
Results: Although there was no statistical difference between Groups 1 and 2, the data demonstrated that both groups improved their VAS scores for axial pain at the final follow-up as compared to preoperative values. At the conclusion of the follow-up period, there was still a statistical difference between the two groups, suggesting that both groups had improved, and each group displayed a statistically significant change in the JOA score from preoperative values.
Conclusion: When performed in conjunction with anterior cervical discectomy and fusion (ACDF), the adjunctive PCL treatment can safely and effectively treat hourglass CSM.
Keywords: CSM, ACDF, PCL, Hourglass.

INTRODUCTION
CSM is a common spinal disorder that narrows the cervical spinal canal due to both congenital and degenerative alterations, causing considerable neurological impairment [(1)]. Many patients with CSM have complex cervical spondylotic myelopathy (cCSM), a disorder that affects at least three levels of the spinal cord simultaneously and causes the cervical spine to appear hourglass-shaped on magnetic resonance imaging (MRI) [(2)].

There are problems of bone and soft tissue compression. Soft-compression disorders may include intervertebral discs, venous plexuses, hypertrophic ligaments, and spinal edema. Osteophytes, hyperplastic facets, ossification of the posterior longitudinal ligaments, and calcified intervertebral discs are some of the conditions that can put strain on the front of the spine.

The hallmark of hourglass or cCSM is minor cervical trauma that frequently leads to significant acute spinal cord injury to the cervical area [(3-4)]. Furthermore, they typically advance quickly in the brief period following the onset of clinical symptoms. Therefore, for the hourglass or complex CSM, earlier action is required.

Surgery can be required if neurological symptoms are present in order to prevent further damage and hasten the healing process [(5)]. The objective of surgically treating CSM is to straighten the spinal cord, relieve pressure on it, and address any instability that may exist. There is continuous discussion on the best surgical technique for treating CSM. Age, sagittal alignment, compression site (ventral vs. dorsal), illness severity, and prior surgical treatments are some of the criteria that influence the recommended course of action [(6)]. The treatment of CSM usually entails anterior, combined anteroposterior, and posterior surgical techniques. ACDF and anterior cervical corpectomy with fusion (ACCF) were successful therapies for CSM [(7, 8)].

With front-facing procedures, compressive lesions such disc herniation and disc-osteophyte complex can be removed from the anterior spine. The anterior approach has the advantage of being able to treat and frequently correct cervical kyphosis. Anterior techniques are linked to shorter hospital stays, less postoperative discomfort, and fewer problems than posterior procedures. When dealing with numerous damaged segments or ossification of the posterior longitudinal ligament (OPLL), choose posterior treatments. The ineffectiveness of the anterior approach may lead to inadequate decompression with a single ventral surgery. The anterior technique alone cannot remove dorsal compression because cervical lordosis theoretically restricts the anterior displacement of the spinal cord [(9, 10)].

When there is more than two levels of anterior interbody grafting, pseudoarthrosis is more likely to occur. Two operations that raise the risk of instability and associated problems include corpectomy and multilayer discectomy. This method might not be sufficient to treat multilayer hourglass CSM, where compressions occur at multiple levels from both the dorsal and ventral regions [(11-12)]. For surgical care of CSM, a posterior approach may be considered if there is ossification of posterior longitudinal ligament (OPLL), rostral disease at the C2-C3 level, are elderly, or have stenosis affecting three or more levels. The

Received: 03/09/2024
Accepted: 03/11/2024

posterior techniques are laminectomy, laminoplasty, and laminectomy with fusion [13, 14].

A cervical laminectomy surgeon will first remove the lamina, interspinous, and supraspinous ligaments in order to do decompression. The afflicted levels of the ligamentum flavum will then undergo posterior resection. This procedure will keep going until the canal enlarges posteriorly, which will enable the spinal cord to retract and decompress. The likelihood of kyphotic deformity later developing, which occurs in 21–42% of instances, is a significant issue with conducting a laminectomy alone. Since the posterior approach is thought to be excessively dangerous, surgery for a fixed cervical kyphotic deformity frequently uses a ventral or hybrid technique. The integrated technique effectively removes compressions from the ventral and dorsal sides of the thecal sac by combining ACCF and ACDF with laminoplasty or laminectomy, thereby expanding the canal from the front and back to relieve enough pressure [7, 15].

This may consequently be the most effective way to treat multilayer hourglass CSM. However, the integrated method may raise the risk of spinal cord injury because the patient has to be moved throughout the single-stage therapy [16, 17]. Pseudoarthrosis, instability, and a higher risk of complications are possible drawbacks of the combined approach as an anterior procedure. Previous studies have demonstrated that the one-stage combination technique yields superior neurofunctional improvement in the treatment of multilayer hourglass CSM [18, 17, 19, 20]. This treatment offers greater neurofunctional improvement at a lower cost and with less discomfort than the two-stage combo approach [16]. This study compared the clinical results of ACDF alone with those of a one-stage combined approach (ACDF followed by PCL at the same level during the same procedure) in patients with hourglass CSM.

PATIENTS AND METHODS

Study design and patient enrollment: This retrospective case series analysis followed 30 patients who had surgery for symptomatic cervical spondylotic myelopathy at the Neurosurgery Departments of Menoufia University between January 2017 and January 2023. Two patient groups were present: The first group of patients to have a combination approach, which included ACDF and PCL at the same level during the same procedure were fifteen patients. The fifteen patients in Group Two, however, underwent ACDF procedures.

Inclusion criteria: Individuals who had symptoms of C3–7 CSM and MRI-verified causative segments, as well as a history of ineffective conservative treatment for at least three months.

Exclusion criteria: Those who had a history of cervical or spinal operations, infections, cancers, or who deliberately withdrew their consent.

We extracted demographic information, surgical duration, intraoperative blood loss, hospitalization, and complications from medical records.

Surgical technique: General anesthesia was administered. The initial position was supine. The use of lateral fluoroscopy was necessary to guarantee the exact level. The surgeon used a right-sided method to make an incision at the designated neck level. After platysma separation, blunt dissection of the deep prevertebral fascia was required. It was possible to remove the posterior longitudinal ligament, degenerative discs, and hyperplastic osteophyte using a second fluoroscopy. There were cages filled with bone fragments in the intervertebral area between vertebrae C3-6. The incision was able to gradually close thanks to the use of sutures. 48 hours following the procedure, we inserted and removed a drainage tube. In situations when a combined technique was employed, the patient was turned over once the ACDF operation was complete. Lateral fluoroscopy allowed us to determine the surgical level. We employed a midline open technique, which entailed slicing the muscles on both sides, to reach the back of the spine. Damaged levels had their ligamentum flavum, bilateral lamina, and spinous processes removed. The articular process must remain outward for more than half of its length. 48 hours following the procedure, we inserted and removed a drainage tube. The wound closure involved eight or ten subcutaneous and facial sutures. Demographic details such as age, sex, BMI, duration of follow-up, operating time, blood loss during surgery, and complications during or following the procedure were among the outcomes that patients reported both at baseline and following surgery.

Radiographic evaluation: Anterior-posterior and lateral X-rays, cervical CT scan, and MRI were conducted before and one-year post-surgery. On a standing lateral radiograph of the cervical spine, the C3-7 Cobb angle measured the angle formed by two intersecting perpendicular lines parallel to the superior endplate of C3 and the inferior endplate of C7. It is used to determine the extent of spinal abnormalities. The following is the definition of the curvatures of C3–C7: Cobb angle ≤ 5 for lordosis; 0 < Cobb angle < 5 for straight; and < 0 for kyphosis [20].

Functional evaluation: One day prior to surgery and one year following the procedure, the Japanese Orthopedic Association (JOA) score and the Visual Analogue Scale (VAS) for axial pain were used.

Visual analogue scale: For both acute and chronic pain, the VAS is a subjective assessment tool. To record a score, mark a point on a 10-cm line that depicts a continuum from 0 to 10. For example, zero means "no pain," 1–3 means "mild pain," 4–6 means "moderate pain," 7–9 means "severe agony," and 10 means "the most horrible anguish imaginable."

Japanese orthopedic association score: To evaluate a patient's neurological condition, clinicians employ the JOA score, a statistic unique to each disease. Upper extremity motor dysfunction, lower extremity motor dysfunction, upper extremity sensory function, trunk sensory function, lower extremity sensory function, and bladder function are the six domain scores that make up this scale. Those scores range from 0 to 4, with a minimum total score of 0 and a maximum total score of 17. Mild myelopathy is defined as having a JOA score greater than 13, moderate myelopathy with a score between 9 and 13, and severe myelopathy with a score less than 9.

Sample size estimation: At Menoufia University's Neurological Departments, 30 patients with symptomatic CSM were operated on between January 2017 and January 2023 as a part of a retrospective study. One group of patients had both ACDF and PCL, while the other group only had ACDF.

Ethics approval: After being given a clear and concise explanation of the study's objectives, the participant's legal guardian completed an informed consent form. The 1964 Declaration of Helsinki and its later amendments or comparable standards, as well as The Institutional and National Research Committees' Ethical guidelines, were fully followed in this work. The research protocol (NRLI IRB protocol number: 11/2023NEUS1) was green-lit by the Menoufia University Faculty of Medicine's Local Ethical Scientific Committee.

Statistical analysis

SPSS version 27.0 was used. The Shapiro-Wilk test and histograms were used to evaluate the data distribution's normality. Quantitative parametric data were presented as mean ± SD and evaluated using an unpaired Student's t-test. Quantitative non-parametric data were represented as the median and IQR and were evaluated using the Mann-Whitney test. Repeated measures ANOVA was used to compare measurements within the same group. The qualitative variables were presented as frequency and percentage (%) and were analyzed using the X^2-test or Fisher's exact test, as appropriate. A two-tailed P value ≤ 0.05 was considered statistically significant.

RESULTS

An illustration of the study group, which consisted of 39 patients with symptomatic CSM who underwent surgery at Menoufia University's Neurosurgery Departments between January 2017 and January 2023. With nine patients removed from the trial (six did not meet the inclusion criteria, and three rejected consent), there were thirty participants left. Group one comprised 15 patients who underwent a combined procedure (Anterior cervical discectomy and fusion followed by PCL at the same level in a single surgery), while Group two comprised 15 patients who only received anterior cervical discectomy and fusion (Figure 1).

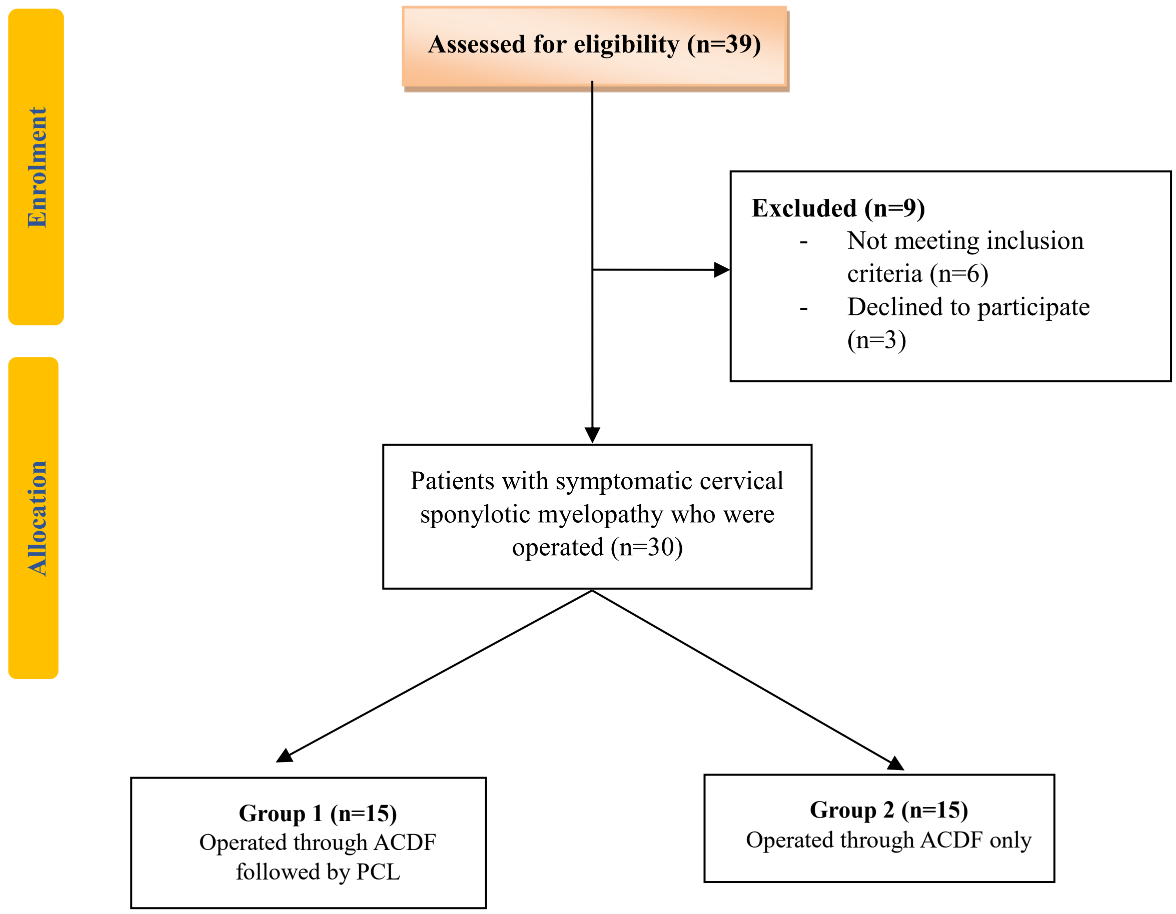

Figure (1): Flowchart of patients with symptomatic CSM who were operated.

Thirty people with symptomatic CSM were participating in this investigation. Group 1 consisted of 15 patients (8 males and 7 females, with a mean age of 56.33 ± 6.56 years) who received a 1-stage combination treatment. Group 2 also included 15 patients (9 males and 6 females, with a mean age of 55.8 ± 7.01 years) who underwent only ACDF. Group 1 patients had a one-stage combination treatment for 16.27 ± 3.43 months, while group 2 patients received ACDF alone for 16.47 ± 4.6 months. There were no statistically significant differences between the two groups in terms of follow-up length, gender, or age. Three instances in group 1 (using the one-stage combined technique) underwent ACDF at one level, eight cases at two levels, three cases at three levels, and one case at four levels. Two instances in group 2 (which only used ACDF) had the procedure done at one level, nine cases at two levels, three cases at three levels, and one case at four levels. The surgical duration was 154 ± 25.01 minutes for group 1 (using the combined approach) and 77 ± 22.5 minutes for group 2 (using ACDF exclusively). The intraoperative hemorrhage was 200.67 ± 42.34 ml and 146.67 ± 26.9 ml for group 1 & group 2 respectively; and the length of hospitalization was 3.14 ± 0.86 days and 2.2 ± 0.41 days respectively. The length of hospitalization, intraoperative blood loss, and operation time all showed statistically significant differences between the two groups (Table 1).

Table (1): Preoperative and operation data of the studied groups

Variables		**Group 1 ACDF + PCL (No = 15)**	**Group 2 ACDF only (No = 15)**	**P value**
Age (years)		56.33 ± 6.56	55.8 ± 7.01	0.831
Sex	**Male**	8 (53.33%)	9 (60%)	0.713
	Female	7 (46.67%)	6 (40%)	
Duration of symptoms before surgery (min)		6 ± 2.65	6.2 ± 2.6	0.836
Levels	**C 3-4**	3 (9.09%)	2 (6.06%)	0.642
	C 4-5	8 (24.24%)	9 (27.27%)	0.778
	C 5-6	13 (39.39%)	13 (39.39%)	1
	C 6-7	8 (24.24%)	9 (27.27%)	0.778
Operation time (min)		154 ± 25.01	77 ± 22.5	**<0.001***
Intraoperative blood loss (ml)		200.67 ± 42.34	146.67 ± 26.9	**<0.001***
Length of hospital stays (days)		3.14 ± 0.86	2.2 ± 0.41	**<0.001***
Follow-up duration (months)		16.27 ± 3.43	16.47 ± 4.6	0.894

*: significantly different as P value ≤0.05. Data are presented as mean ± SD or frequency (%).

In terms of the axial pain VAS score, Group 1 (Using the 1-stage combination approach) had a median preoperative axial pain VAS score of 5 (range 4–6) and a median preoperative JOA score of 11 (range 9–12). The preoperative JOA score was 11 (range 10–13) and the preoperative VAS score for axial pain was 5 (range 4-6) in group 2 (treated solely via ACDF). There was no statistically significant difference in the two groups' preoperative axial pain VAS scores. At the last follow-up, group 1 (Which underwent surgery using the one-stage combination approach) showed an improvement in their VAS score for axial pain to 2 (1–2), while group 2 (Which underwent surgery using ACDF alone) showed an improvement to 1 (1–2). Each group's difference from the preoperative levels was statistically significant (P < 0.05).

At the final follow-up, however, there was no statistically significant difference between the two groups (P > 0.05). Neither group's preoperative JOA scores were statistically significant. The JOA score increased to 16 (14.5–16) in group 1 (using the one-stage combination technique) and to 15 (13–15) in group 2 (using ACDF exclusively) at the last follow-up. Each group showed a statistically significant difference from the preoperative values (P < 0.05), and the two groups showed a statistical difference at the end follow-up (P < 0.05). According to table (2), the Cobb angle did not significantly alter between preoperative and postoperative measurements in either group, nor did postoperative data within each group differ significantly from preoperative measures (P > 0.05) (Table 2).

Table (2): VAS score, JOA score and Cobb angle of the studied groups

Variables	Preoperative	Postoperative	P value
VAS score of the axial pain			
Group 1 ACDF + PCL (No = 15)	5 (4 - 6)	2 (1 - 2)	**<0.001***
Group 2 ACDF only (No = 15)	5 (4 - 6)	1 (1 - 2)	**<0.001***
P value	0.713	0.461	
JOA score			
Group 1 ACDF + PCL (No = 15)	11 (9 - 12)	16 (14.5 - 16)	**<0.001***
Group 2 ACDF only (No = 15)	11 (10 - 13)	15 (13 - 15)	**0.001***
P value	0.566	**0.036***	
Cobb angle (◦)			
Group 1 ACDF + PCL (No = 15)	15.27 ± 1.94	14.2 ± 1.8	**0.385**
Group 2 ACDF only (No = 15)	15.68 ± 1.36	14.8 ± 1.23	**0.720**
P value	**0.816**	**0.685**	

*: significantly different as P value ≤0.05. Data are presented as median (IQR) or mean ±SD. VAS: Visual Analogue Scale, JOA: Japanese orthopedic association score.

Group (1) (Which underwent surgery using the first-stage combined method) experienced two cases of dysphagia and one incidence of hoarseness of voice, both of which resolved on their own within two months. Two patients suffered C5 nerve root palsy, which resolved with neurotrophic medications six months after surgery. Debridement and daily dressings were able to resolve the superficial wound infection that developed in two cases of the posterior wound. One patient experienced a dural tear during the decompression treatment, which was repaired with tight suturing. Within two months, two cases of dysphagia and one incidence of hoarseness of voice in group 2 (Operated by the ACDF solely) resolved on their own. One example had a minor superficial wound infection in the anterior area, which went away with daily dressing changes. In three cases, the neurological condition worsened after surgery, and after receiving high doses of intravenous solumedrol and neurotrophic medications, the condition did not improve. Following two days, a postoperative MRI showed cervical canal stenosis. Because the chord was still constricted, PCL was performed three days following the initial procedure. Physiotherapy and neurotrophic medications helped these patients gradually improve over the course of six months. No hematoma, pseudoarthrosis, implant problems, or deaths occurred during follow-up in either of the two groups (Table 3).

Table (3): Complications of the studied groups

Variables	Group 1 ACDF + PCL (No = 15)	Group 2 ACDF only (No = 15)	P value
Hoarseness	2 (13.33%)	2 (13.33%)	1.00
C5 palsy	2 (13.33%)	0 (0%)	0.482
Dysphagia	2 (13.33%)	2 (13.33%)	1.00
CSF leakage	0 (0%)	0 (0%)	---
Neurological deterioration	0 (0%)	3 (20%)	0.224
Infection	2 (13.33%)	1 (6.67%)	1.00
Pharyngodynia	1 (6.67%)	1 (6.67%)	1.00

*: significantly different as P value ≤0.05. Data are presented as frequency (%). CSF: Cerebrospinal fluid leak.

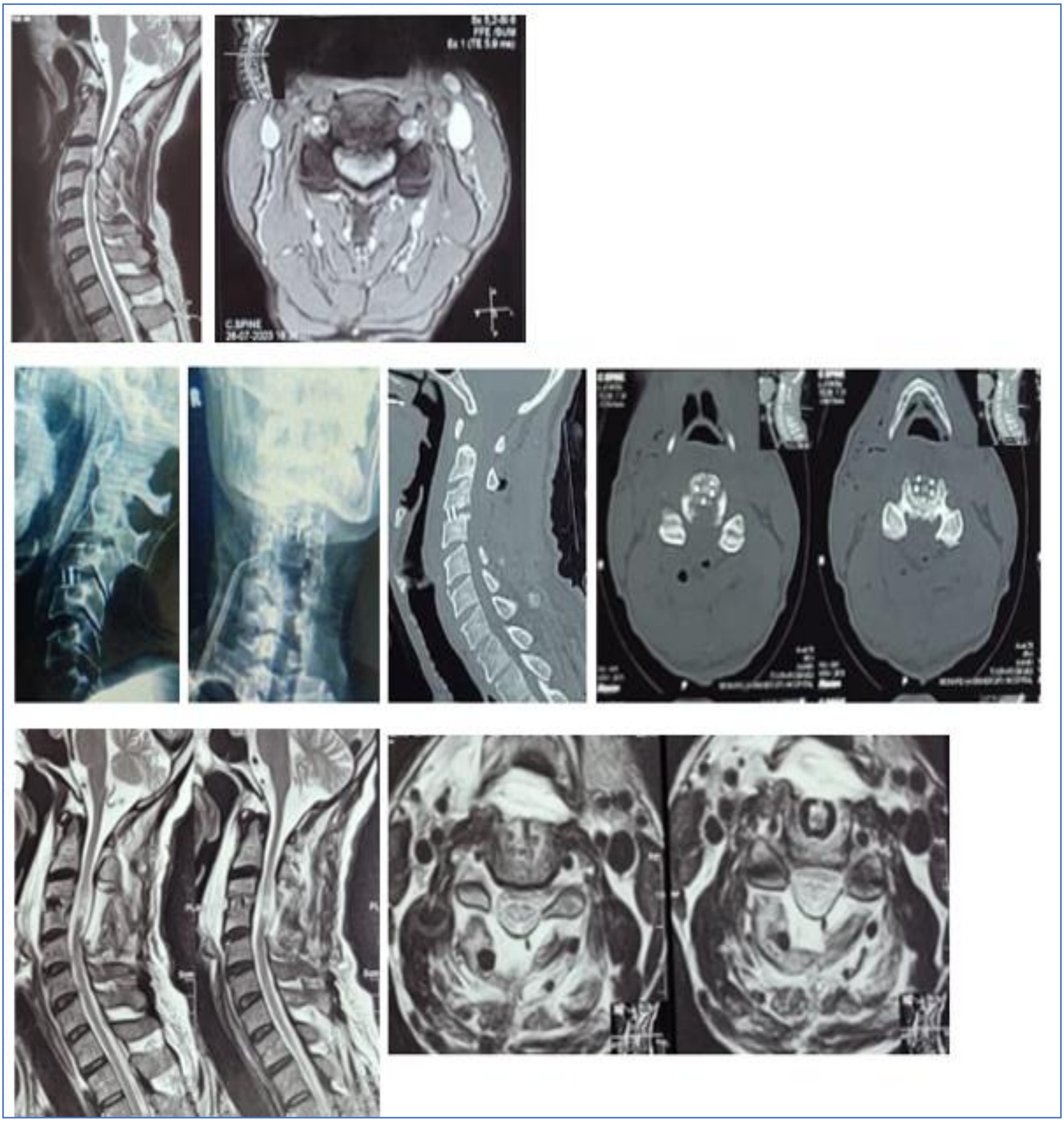

Figure (1): Male patient, 52 y old presented with CSM. Preop VAS score of axial pain was 5. The preop JOA score was 8. MRI cx sp sagittal and axial T2 (a and b) revealed C3-4 CDP causing anterior compression and buckling of the ligamentum flavum causing posterior compression at the same level. The spinal cord showed severe cord compression and contusion. ACDF at C3-4 level with cage was done followed by PCL at the same level in the same sitting. (C & D) postop X Ray cx sp A-P & Lat views, (f.) postop CT cx sp, (g. and h.) postop MRI cx sp; sagittal and axial T2; revealed C 3-4 ACDF with cage together with C 3,4 posterior cervical laminectomy with good decompression of the cord. Postoperatively, VAS score of the axial pain was improved to 2 and JOA score was improved to 14.

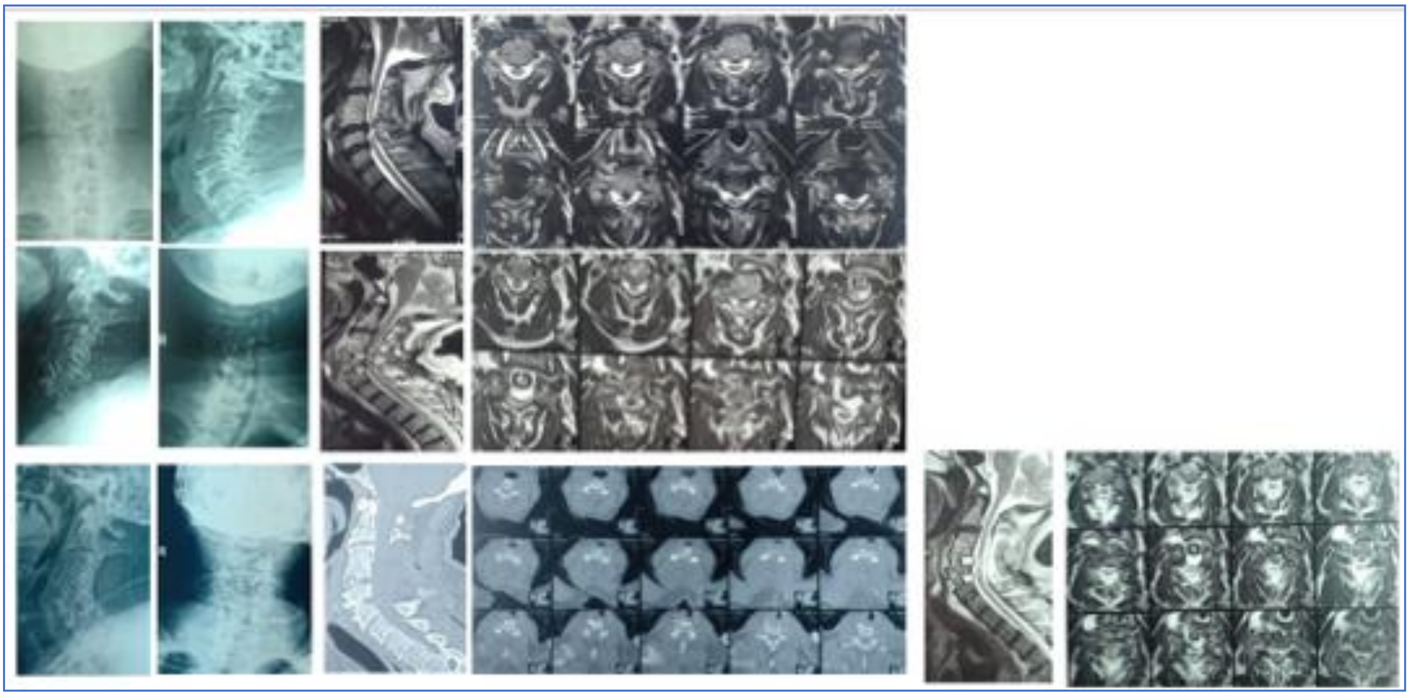

Figure (2): Male 58 y old with CSM, Preop VAS score for axial pain was 6 and preop JOA score was 9. (a & b) preop X Ray cx sp and (c., d.) MRI cx sp sagittal and axial views revealed C4-5, 5-6 CDP causing ant cord compression and buckled ligamentum flavum causing posterior compression at these levels. ACDF was done but the patient deteriorated neurologically. (e., f., g., H.) postop X ray cx sp and MRI cx sp; revealed cord compression and stenotic canal. After 3 days, in a second sit, PCL was done. (j., k., L., m., n., o) postop X ray, CT, MRI cx sp after the second sit, revealed good decompression. The patient was improved neurologically with physiotherapy and neurotrophic drugs. At the final follow up, VAS score improved to 2 and JOA score improved to 13.

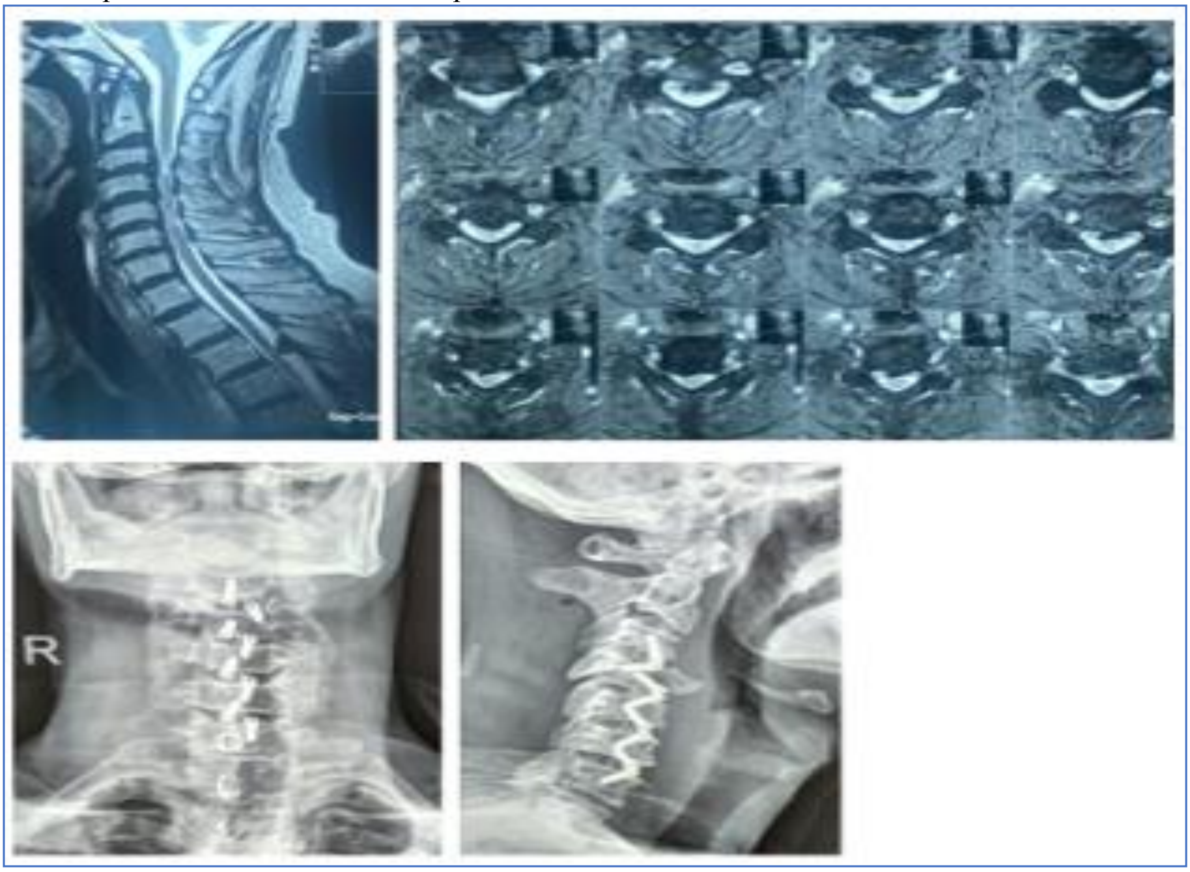

Figure (3): Male patient 55 y old presented with CSM. Preop VAS score for axial pain was 5 and the preop JOA score was 9. Preoperative MRI sagittal and axial views (a and b) revealed C3-4, 4-5, 5-6, 6-7 CDP compressing the cord from anterior and canal stenosis and buckling of the ligamentum flavum compressing the cord from posterior. Surgical treatment was done by the combined approach; in the supine position, ACDF was done at the four levels then the patient was positioned prone, and PCL was done in the same sitting. Postoperatively, the VAS score for axial pain was improved to 2 and the JOA score was improved to 14.

DISCUSSION

A thorough and customized strategy is necessary for the surgical care of patients with multilayer hourglass CSM. Creating the most successful surgical strategy depends on a number of variables. The severity and localization of multilevel hourglass CSM, spinal alignment (stable or unstable, lordotic or kyphotic), degrees of congenital canal stenosis (single, double, or multiple levels), symptomatology (Axial neck pain present or absent), preexisting medical comorbidities, the complexities of the compressive pathology (ventral, dorsal, or both; soft tissue or osseous), the surgeon's experience, and their preferred surgical technique must all be taken into account when determining the criteria for surgical intervention [(21, 23)].

For multilayer hourglass CSM, a variety of surgical techniques have been developed and applied, such as anterior, posterior, single-stage, and two-stage combined anterior and posterior procedures. Nineteen, eighteen, seventeen, sixteen. The best surgical method is still up for debate. The gold standard for treating cervical spondylotic radiculopathy and instances with one or two levels of CSM is conventional ACDF; however, its effectiveness for treating multilevel CSM is still up for question [(24)].

There is ongoing discussion on the best surgical method for treating multilevel CSM, particularly when there is both ventral and dorsal compression, because the anterior surgical approach is insufficient to decompress the posterior canal space. A typical surgical technique for treating multilevel CSM with ossification of the posterior longitudinal ligament (OPLL) is cervical laminectomy with fusion. When multilayer CSM affects more than three segments, posterior decompression surgery is a common surgical procedure [(25)].

Significant paraspinal muscle dissection is necessary for posterior surgeries, which can lead to a reduction in cervical lordosis and range of motion as well as postoperative axial neck pain. The clinical care of multilayer hourglass CSM has seen a growing use of the integrated strategy in spinal procedures, which has shown improved neurofunctional improvement. Restoring normal dural pulsation by unhindered cerebrospinal fluid circulation, spinal canal expansion through laminectomy, spinal cord recession, and the removal of anterior compression problems with ACDF were all components of the integrated therapy. Decompression and spinal canal enlargement probably contributed to the combined treatment's improved clinical outcomes [(17, 18, 22)].

Participants in this study had a diagnosis of CSM with symptoms. Group 1 of the patients underwent a simultaneous ACDF and PCL at the same level during the same procedure. Group 2 only used ACDF for operations. There were no statistically significant differences between the two groups in terms of follow-up duration, gender, or age. The length of hospitalization, intraoperative blood loss, and operation time all showed statistically significant differences between the two groups. Group 1, which used the combined technique, had a longer surgical duration. The necessity of altering the surgical position during the combination treatment could be the cause of this. After undergoing ACDF surgery in a supine position, the patients had PCL treatment in a prone position. This part of the strategy only used a little amount of the operating time. According to **Zhou *et al.*** [(2)], the combined group experienced an intraoperative blood loss of 710.0 ± 41.8 milliliters and an average surgical duration of 216.03 ± 33.21 minutes. According to **Wang *et al.*** [(26)] the ACDF group experienced a blood loss of 392.14 ± 128.06 milliliters and an operative duration of 172.64 ± 31.96 minutes. Compared to group 2, which received only ACDF, group 1, which used the combined method, showed noticeably higher blood loss. In technical terms, ACDF operations are quite minimally intrusive. Skilled training and knowledge can effectively control intraoperative hemorrhage. Significant dissection of the paravertebral muscles and bone structures is necessary during posterior laminectomy, which increases intraoperative blood loss. This is in line with findings of **Seng *et al.*** [(27)].

There was no statistical difference between the two groups' preoperative axial pain VAS scores, but both groups' postoperative improvements over preoperative values were statistically significant, and there was no statistical difference between the groups at the final follow-up. According to **Zhou *et al.*** [(2)], patients in the combined method group experienced a decrease in their postoperative VAS score from an average of 4.0 ± 1.1 to 1.7 ± 0.5 points at baseline. In the ACDF group, **Wang *et al.*** [(26)] demonstrated a noteworthy improvement in the axial VAS after surgery (3.43 ± 0.98 to 2.10 ± 0.70).

Although each group showed a statistically significant change from their preoperative values, the preoperative JOA scores of the two groups were statistically identical. The most recent follow-up revealed a statistically significant difference between the two groups. For CSM and cervical spinal canal stenosis, **Liu *et al.*** [(28)] demonstrated that decompression using a combination of posterior and anterior techniques is a safe and effective surgical procedure. The mean preoperative JOA score was 9.36 ± 2.24 points; three months and a year after surgery, the JOA score was 12.34 ± 2.64 points and 12.77 ± 2.61 points respectively indicating a considerable improvement.

Out of the 44 cases, 16 had extraordinary results, 19 had satisfactory results, 6 had mediocre results, and 3 had invalid results. There were statistical differences between the preoperative score and the scores recorded three months or a year after the procedure. Repositioning the spinal cord posteriorly by increasing the degrees of openness was necessary to achieve adequate neurological improvement after surgery in patients with hourglass CSM treated with a one-stage combination approach (laminectomy and ACDF). The improvement was evident in the decline in VAS values and the rise in JOA scores.

The JOA score has been used to assess the efficacy of decompression rather than as a direct indicator of decompression [19]. At every data collecting interval, there was a statistically significant difference in the neurofunctional improvement between the two groups (P<0.05). This result demonstrated how well decompression worked for the group using both techniques. According to our research, the C3–C7 Cobb angle in the anterior approach cohort dropped from an average of 15.68 ± 1.36 before surgery to 14.8 ± 1.23 after. The angle dropped from an average of 15.27 ± 1.94 to 14.2 ± 1.8 (preoperative to postoperative) in the combined approach group. There was no statistically significant difference between the two groups in terms of the preoperative Cobb angle (P>0.05), postoperative Cobb angle (P>0.05), and change in Cobb angle (P>0.05). According to **Zhou *et al.*** [2]**,** the angle dropped from an average of 16.5 ± 11.1 to 9.4 ± 6.9 (preoperative to postoperative) in the combined approach cohort. By restoring the interbody stabilization of the spinal vertebrae and realigning them, this condition may help to relieve tension on the vertebrae and promote normal dural pulsation by allowing unhindered cerebrospinal fluid flow.

Laminectomy, which involved spinal cord retraction and the relief of some soft tissue compression disorders, widened the spinal canal. Two instances (13.3%) in the PCL group in our study had C5 nerve root palsy; conservative treatment completely alleviated the symptoms six months after surgery. The posterior displacement of the spinal cord and the tethering of the nerve root were most likely the causes of this problem. After posterior cervical decompression surgery, the average incidence of C5 nerve root palsy was 7.8%, according to **Pan *et al.*** [29]**.**

Decompressing the C5 nerve root is the goal of the suggested preventive C4–5 foraminotomy intervention, which is based on the theory that nerve traction and foraminal stenosis cause post-laminectomy C5 palsy. All patients with foraminal stenosis who had laminectomy and fusion had prophylactic bilateral C4/C5 foraminotomy because data show that this procedure significantly reduces the incidence of postoperative C5 palsy (1.4% in the foraminotomy group compared to 6.4% in the non-foraminotomy group). However, patients who exhibit prolonged symptoms and notable cord signal alterations at C4–5 may still have C5 palsy [30, 31]. Infection of the incision and delayed wound healing were additional concerns associated with the procedure. There was also an intraoperative dural rip in one case, which was fixed by securely closing the dural sac. Additionally, debridement and regular dressing changes were able to treat superficial wound infections at the posterior site in two cases. According to **Kristof *et al.*** [32] following posterior decompression surgery, the incidence of wound infection was 6.5%. According to the current study, during the follow-up period, neither group experienced hematoma, pseudoarthrosis, implant problems, or mortality.

Finally, for hourglass CSM, the authors used either the anterior method (ACDF) or a one-stage combination operation (laminectomy with ACDF). In hourglass CSM, these treatments may consistently slow the myelopathy's progression. Significant neurological improvement and pain reduction were the outcomes of both treatments. In terms of decompression and neurological improvement, the one-stage combination treatment (laminectomy with ACDF) outperformed the anterior approach alone (ACDF) without causing more problems. In terms of surgical expenses, duration, and blood loss, the anterior approach alone (ACDF) performed better than the single-stage combo surgery.

Limitations of the study: This monocentric study's retrospective methodology, patient enrollment heterogeneity, and lack of randomization raise the possibility of selection bias, which could have affected the study's findings.

CONCLUSIONS

Hourglass cervical spondylotic myelopathy can be safely and effectively treated by the adjunctive PCL operation in conjunction with ACDF.

No funds.
No conflict of interest.

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