Turk Neurosurg, 2021

Original Investigation

DOI: 10.5137/1019-5149.JTN.33981-21.2

Received: 02.02.2021
Accepted: 10.06.2021

Published Online: 02.12.2021

An Assessment of the Effectiveness of Surgical Treatment Methods Used for Cervical Spondylosis

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ABSTRACT

AIM: To evaluate the preoperative and postoperative clinical and radiological findings of patients treated surgically for cervical spondylosis.

MATERIAL and METHODS: The patients included in the study (n=32) were divided into three groups according to their preferred surgical approach. These surgical approaches are posterior cervical laminectomy, posterior cervical laminectomy plus fusion, and anterior approach. Then, pre-and postoperative modified Japanese Orthopaedic Association Myelopathy (mJOA) scores, Torg-Pavlov ratios measured on direct cervical radiography, and pre-and postoperative lordosis angles were recorded. The data obtained were evaluated statistically.

RESULTS: The radiological examinations revealed that the average preoperative Torg-Pavlov ratio was < 1 in 29 patients. The average sagittal spinal canal diameter was 9 mm, and myelomalacia was detected in 25 patients. Postoperative mJOA scores in patients who underwent anterior corpectomy and fusion and posterior laminectomy were statistically significant (p<0.05). The highest symptomatic recovery rate was found in patients with preoperative neck pain. This finding was not statistically significant (p>0.05). Changes in the postoperative lordosis angles and recovery rates were also observed, depending on the preferred surgical approach.

CONCLUSION: If there is no kyphotic deformity or straightening of the cervical lordosis, a posterior laminectomy can be performed to avoid the long-term complications caused by an anterior corpectomy. It should be kept in mind that multi-segment and wide laminectomies may cause instability problems.

KEYWORDS: Cervical lordosis angle, mJOA score, Cervical anterior corpectomy, Cervical posterior laminectomy

INTRODUCTION

Cervical spondylosis is a disorder commonly seen in older ages that results in progressive disc degenerations (8). Spondylosis, a natural result of the aging process, significantly affects cervical intervertebral discs and facet joints (2,16,19). A comprehensive understanding of biomechanics, pathology, and clinical presentation is crucial for the effective management of patients with cervical spondylosis (28).

Intervertebral discs and facet joints play a role in transmitting external force and provide intervertebral connection and mobility to the cervical region (17,18). The degeneration of disc structure and facet joints leads to the compression of the spinal cord at one or more levels (7,21). Spinal cord injury may also occur due to ischemic changes in the medulla spinalis (42).

Cervical spondylosis is the most common cause of myelopathy symptoms in patients over 40 years of age, and

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it is a result of pathological changes in the cervical spinal region, such as congenital spinal canal stenoses, disc hernias, vertebral osteophytes growing into the spinal canal and facet joints, ligamentum flavum hypertrophy, and degenerative or calcified posterior longitudinal ligament. Age, localization of spinal cord compression, cervical spinal alignment, number of cervical segments involved, and hyperintensity seen in MRI examinations are essential parameters in choosing the appropriate surgical treatment method.

Surgical methods are recommended for the effective treatment of patients unresponsive to medical and conservative treatment (3). An anterior (36), posterior (45), or combined (23) approach can be used for surgical treatment. The most commonly preferred methods in the surgical treatment of cervical spondylosis are as follows: anterior cervical discectomy and fusion, anterior cervical corpectomy and fusion, lamino-foraminotomy, laminectomy, laminoplasty, or laminectomy and fusion.

The present study aimed to investigate the factors affecting preoperative and early postoperative clinical and radiological findings in patients who underwent operations for the treatment of cervical spondylosis. The recovery rates based on postoperative Modified Japanese Orthopaedic Association (mJOA) scores and changes in lumbar lordosis angles of each surgical approach used were also compared. The data obtained were assessed statistically in line with the methods used in the current literature.

MATERIAL and METHODS

The data used in the present study were retrieved from the medical records of cervical spondylosis patients who were operated on at Haydarpasa Numune Training and Research Hospital, Brain and Nerve Surgery Clinic between January 2004 and December 2009. Written approval to use the patients' data was received from the hospital administration.

Of the patients (n=50), those with data missing from their medical records were excluded. Patients with neck and arm pain, numbness, weakness in the arms and legs, and gait disturbance were included in the study. Patients with spinal tumors, spinal infections that may create the same clinical picture, or concomitant minor symptoms, such as headache or tingling in the hands, were also excluded, leaving a total of 32 patients.

The medical records of these 32 cases were retrieved. Demographic data and all medical data described in their anamnesis, including presenting symptoms, duration of symptoms, and clinical findings, were also extracted.

The patients included in the study (n=32) were divided into three groups according to their preferred surgical approach. Nine patients with a normal preoperative cervical lordosis angle and without preoperative instability underwent laminectomy. Laminectomy plus lateral mass fixation and fusion were performed on patients with cervical lordosis loss and a higher risk of postoperative cervical kyphosis. Patients with one- or two-level cervical disc impairment who underwent cervical corpectomy and anterior cervical fusion served as Group I (n=12). Patients with two-level cervical disc impairment or higher who underwent posterior cervical laminectomy served as Group II (n=9). Group III (n=11) included patients who underwent posterior cervical laminectomy and posterolateral cervical fusion with lateral mass screw fixation.

Preoperative and postoperative mJOA scores, lordosis angles, and Torg-Pavlov ratios in direct cervical radiographs were recorded for all groups. Cervical spine alignment, ossification of the posterior longitudinal ligament (OPLL) visualized by cervical computed tomography (CT), cervical magnetic resonance imaging (MRI) sections showing the number of involved segments, and cervical myelomalacia were also recorded.

Preoperative and postoperative mJOA scores, recovery rates, and changes in preoperative and postoperative lordosis angles were reviewed. Neurological examinations were performed to evaluate clonus, Babinski, and Hoffman reflexes, muscle strength, sensory defects, hyperreflexia, hyperactive pectoral muscle reflexes, and the presence of Lhermitte's and Romberg's signs. Then, the patients whose results of the previously listed neurological examinations were pathological findings were examined.

Calculation of the Torg-Pavlov Ratio

The Torg-Pavlov ratio was calculated as follows: the sagittal diameter of the spinal canal was divided by the sagittal diameter of the vertebral body (1). Torg-Pavlov ratios were categorized into three levels: 0.6–0.8, 0.8–1, and > 1.1 (Figure 1).

Calculation of mJOA Recovery Rate

Preoperative and early postoperative clinical findings were scored according to the mJOA classification, and recovery rates were calculated using the formula below (4):

$$\text{Recovery rate (\%)} = \frac{\text{Postoperative score} - \text{Preoperative score}}{\text{18 - Preoperative score}} \times 100$$

Calculation of Lordotic Sequence and Straightening of Lordosis

Cervical alignment, which was visualized with preoperative and postoperative cervical X-rays, was described based on kyphotic alignment, lordotic alignment, and straightening of lordosis. Normal cervical lordosis (Figure 2A) and preoperative and postoperative lordosis angles were measured (Figures 2B and 2C). The sagittal diameter was measured by calculating the distance between the midline of the posterior corpus and the spinolaminar line (Figure 2D). T2-weighted images of the cervical MRI detected any myelomalacia present and the number of degenerative segments (Figure 2E).

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, 17.0 version, Windows) software. The Kolmogorov-Smirnov test was used to examine the for intergroup comparisons of parameters with normal

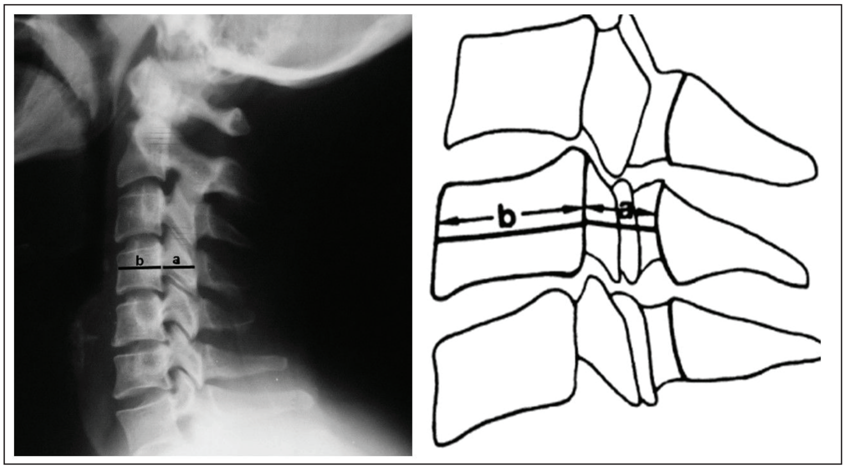

Figure 1: Measurement of the Torg-Pavlov ratio: sagittal diameter of the spinal canal is divided by the sagittal diameter of the vertebral body in a lateral cervical spine X-ray.

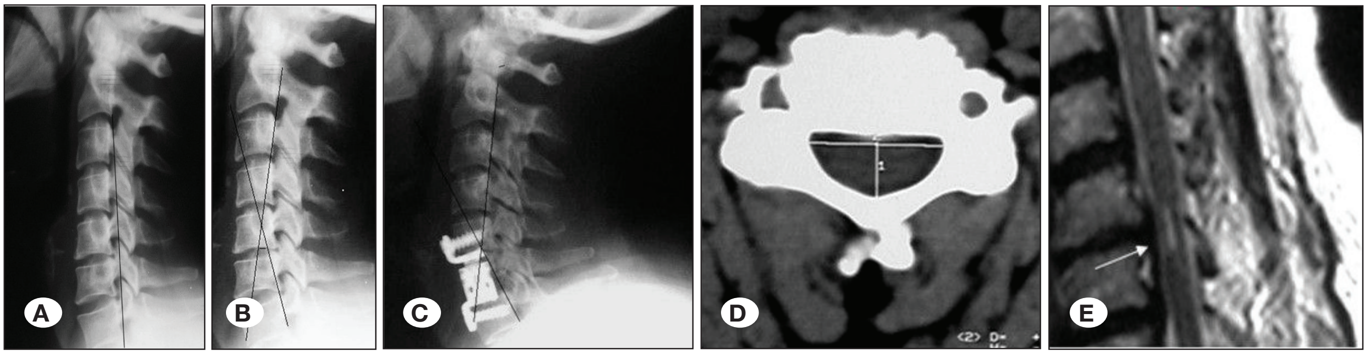

Figure 2: Measurement of preoperative and postoperative cervical alignment parameters. **A)** Evaluation of preoperative cervical sagittal alignment in the lateral cervical spine X-ray. **B, C)** Calculation of the preoperative and postoperative cervical lordosis angle in a patient who underwent operation on the lateral cervical spine X-ray. **D)** Measurement of the cervical spinal canal diameter on axial CT images. **E)** Presence of myelomalacia and the number of degenerative segments on T2W sagittal MRI of the cervical spine.

distribution and descriptive statistics (mean, standard deviation [SD], frequency, percent). The Mann-Whitney U test was used for intergroup comparisons of parameters without normal distribution. The Kruskal Wallis test was used for intergroup comparisons of more than two groups without normal distribution. The Wilcoxon signed-rank test was used for in-group comparisons of parameters. The Spearman correlation coefficient was used to analyze and compare quantitative data. Linear regression analysis was used to examine the outcomes reached by correlation analysis. The results were evaluated at a 95% confidence interval, and the significance level was $p<0.05$.

RESULTS

Of the cases included in the study, 38% (n=32) were female (20 males, 12 females). The age distribution was between 27 and 82 years, with a mean age of 57.9 ± 13.3 years. Among the patients, 53% (n=17) had neck and arm pain, 38% (n=12) had weakness in the arms and legs, and 9% (n=3) had gait disturbance. The period of admission to the clinic ranged from the first day of the symptoms' onset to five years after their onset. The period of admission for 31% (n=10) of the cases was between zero and three months, 44% (n=14) were admitted between three months and one year, and 25% (n=8) were admitted after more than a year.

Assessments were based on the patients' early postoperative findings, including mJOA scores.

Thirteen cases had OPLL, of which 38.4% had a segmental type, 30.7% a continuous type, 23% a mixed type, and 8% a focal type. Torg-Pavlov ratio values were between 0.6 and 0.8 in 12 cases, 0.8 and 1.0 in 17 cases, and over 1.0 in 3 cases. The sagittal spinal canal diameter was 7–9 mm in 12 cases, 9.1–11 mm in 3 cases, and ≥ 11.1 mm in 13 cases.

Six cases had a single pathological segment, 15 had two pathological segments, and 11 had three or more pathological segments. Myelomalacia was observed in 25 cases, with no clinical signs of myelomalacia found in seven cases.

According to the mJOA recovery rate, 100% improvement was observed in 16 cases, and between 51% and 99% improvement was observed in two cases. Four cases showed an improvement between 1% and 50%, and eight cases showed no mJOA score change. Neurological regression was observed in two cases, and the mean recovery rate was 85.9 ± 25.7% in cases that showed improvement. The average recovery rate was between 55.9 and 51.2%.

An evaluation of the significance between age and recovery rate revealed that there was no statistically significant difference in the recovery rates of patients between the ages of 20 and 50 years and those between the ages of 51 and 70 years (p>0.05). The recovery rate of patients aged 71 and over was lower than other age groups, and this result was statistically significant (p<0.05) (Table I).

The recovery rate of patients with pain-related symptoms was more significant than those with weakness-related symptoms (p<0.05). The recovery rate of patients with gait disturbance were less likely to recover, but that this difference was not statistically significant (p>0.05) (Table II).

Correlations between age groups are presented in Table III.

The postoperative increase in mJOA scores was statistically significant in Group I patients who underwent anterior corpectomy and fusion and Group II patients who underwent posterior laminectomy (Table IV).

The increased postoperative cervical lordosis angles of patients in Group I (p<0.05) who underwent anterior corpectomy and fusion was statistically significant (Table V).

A neurological examination of a 40-year-old female patient suffering from neck and left arm pain for two years revealed left C6 dermatomal hypoesthesia and 4/5 paresis in flexion of the left forearm. Preoperative cervical spine X-ray showed straightening of the cervical lordosis and degeneration of the disc space (Figure 3A). C 3-4-5 cervical spondylosis and straightening of cervical lordosis were observed in the preoperative sagittal and axial sections of cervical spine MRI (Figure 3B, C). No additional motor or sensory deficits were detected in the neurological examination in the early postoperative period of the patient, who underwent total laminectomy (C3-4-5-6) and stabilization with a lateral mass screw. Hyperdensity in the lateral masses of the instrumentation system and the laminectomy sites was observed in the postoperative axial CT images (Figure 3D).

A 58-year-old male patient with neck pain and numbness in both arms for six months was admitted to the clinic. A neurological examination revealed bilateral C6 dermatomal hypoesthesia, 4/5 paresis in flexion and extension of the left arm, and frust paresis in flexion of the left forearm. The preoperative cervical spine MRI showed C3-C4 calcified disc herniation, segmental spinal stenosis, and spinal cord hyperintensity

Table I: Correlation Between mJOA Recovery Rate and Age Groups

	Age						
	20-50 years (n=8)		51-70 years (n=17)		71 years and over (n=7)		p
	Average	**Sd**	**Average**	**Sd**	**Average**	**Sd**	
Recovery Rate	75.0	46.3	67.2	49.0	6.9	31.3	**0.015**

mJOA: *Modified Japanese Orthopaedic Association.*

Table II: Correlation Between Presenting Symptoms at Clinic Admission and mJOA Recovery Rate

	Presenting Symptom						
	Pain (n=17)		**Gait Disturbance (n=3)**		**Weakness (n=12)**		**p**
	Average	**SD**	**Average**	**SD**	**Average**	**SD**	
Recovery Rate	82.4	43.1	50.0	50.0	20.0	41.5	**0.002**

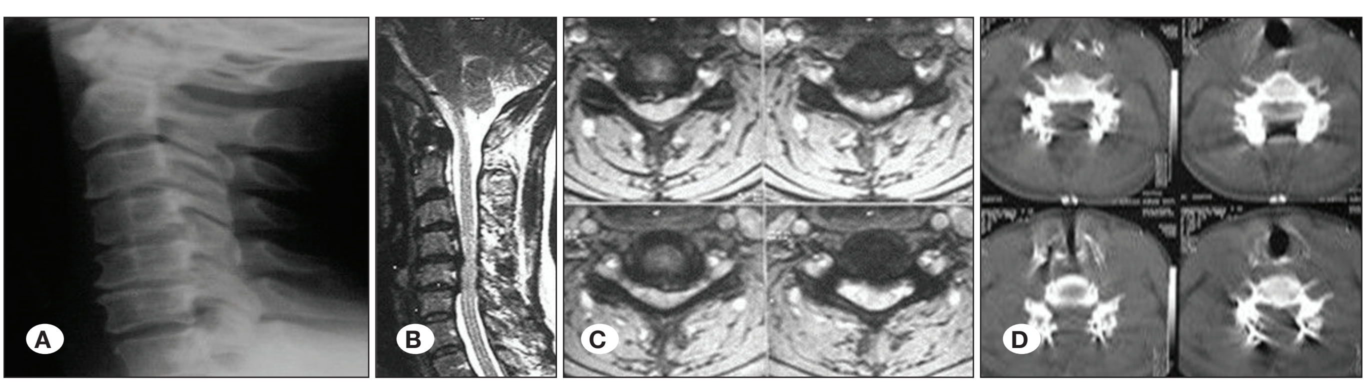

Figure 3: A) Preoperative lateral cervical X-ray image. **B, C)** Preoperative unenhanced T2 W MRI images (sagittal and axial sections). **D)** Postoperative axial cervical spinal CT sections.

Table III: Presenting Symptoms, Cervical Spinal Canal Diameter, and Preoperatively Measured Torg-Pavlov Ratio According to Age Groups

			Age			p
			20-50	51-70	71 and over	
Symptom	Pain	n	6	10	1	0.157
		%	75.0	58.8	14.3	
	Gait Disturbance	n	0	2	1	
		%	0.0	11.8	14.3	
	Weakness	n	2	5	5	
		%	25.0	29.4	71.4	
Canal Diameter (mm)	7-9	n	6	6	0	**0.019**
		%	75.0	35.3	0.0	
	9.1-11	n	1	5	1	
		%	12.5	29.4	14.3	
	11.1 and over	n	1	6	6	
		%	12.5	35.3	85.7	
Torg-Pavlov Ratio	0.6 – 0.8	n	5	7	0	**0.004**
		%	62.5	41.2	0.0	
	0.8 – 1.0	n	3	10	4	
		%	37.5	58.8	57.1	
	1 and over	n	0	0	3	
		%	0.0	0.0	42.9	

Table IV: Changes in mJOA Recovery Rates According to the Preferred Surgical Method

	Anterior corpectomy (n=12)		Posterior laminectomy (n=9)		Posterior laminectomy + stabilization (n=11)		p
	Average	Sd	Average	Sd	Average	Sd	
Pre-op mJOA	16.3	1.0	12.8	4.3	15.9	0.9	**0.010**
Post-op mJOA	17.7	0.7	14.9	4.4	16.8	1.1	0.091

mJOA: *Modified Japanese Orthopaedic Association.*

Table V: Changes in Cervical Spinal Lordosis Angles According to the Preferred Surgical Method

	Anterior corpectomy (n=12)		Posterior laminectomy (n=9)		Posterior laminectomy + stabilization (n=11)		p
	Average	SD	Average	SD	Average	SD	
Pre-op angle	15.8	6.2	25.4	2.5	21.6	8.7	**0.008**
Post-op angle	24.0	4.9	24.0	3.5	24.3	7.6	0.846

SD: *Standard deviation.*

due to myelomalacia (Figure 4A, B). Medical records revealed that the patient had undergone C4 corpectomy, C3-4, C4-5 discectomy, and anterior stabilization with a plate-cage. The postoperative lateral cervical spine X-ray showed satisfactory cervical lordosis after C4 corpectomy and the implementation of an anterior plate-cage system (Figure 4C). The axial cervical spine CT revealed the corpectomy site and an image of the plate-cage (Figure 4D).

A 49-year-old male patient with neck and right arm pain for three years was admitted to the clinic. The cervical spine MRI showed C2-3 segmental spinal stenosis and spinal cord hyperintensity (Figure 5A). The sagittal cervical spine MRI showed a satisfactory C2 total, partial C3 laminectomy, and total neural decompression (Figure 5B). The axial cervical spine CT also revealed a corpectomy site (Figure 5C).

DISCUSSION

Cervical spondylosis is a natural process of aging and the most common cause of myelopathy after the age of 40 (22). Mechanical factors responsible for the formation of cervical spondylosis can be divided into two groups: static and dynamic (41). Static factors are associated with the primary degenerative process, causing narrowing of the sagittal spinal canal diameter (25,38). These factors include congenital spinal canal stenoses, disc herniation, vertebral osteophytes originating from the spinal canal and facet joints, ligamentum flavum hypertrophy, and degenerative or calcified posterior longitudinal ligament (20). Dynamic factors include repetitive normal and abnormal movements of the cervical region and excessive vectorial force exerted on the spinal column and spinal cord while carrying loads, which cause neurological symptoms and deficits in patients with cervical spondylosis (13,39).

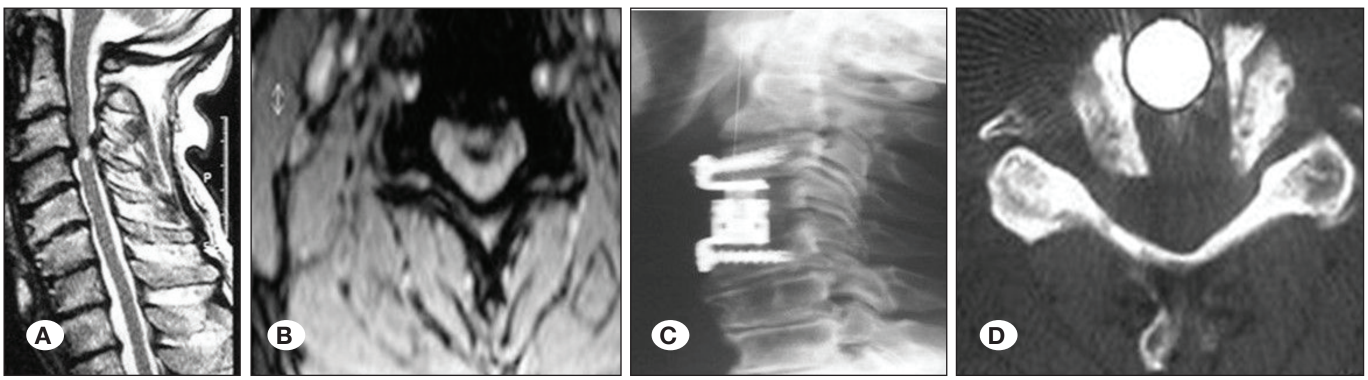

Figure 4: A, B) Preoperative unenhanced T2W cervical spinal MRI image (sagittal and axial sections). **C)** Postoperative lateral cervical spinal X-ray image. **D)** Postoperative acicular cervical spinal CT sections.

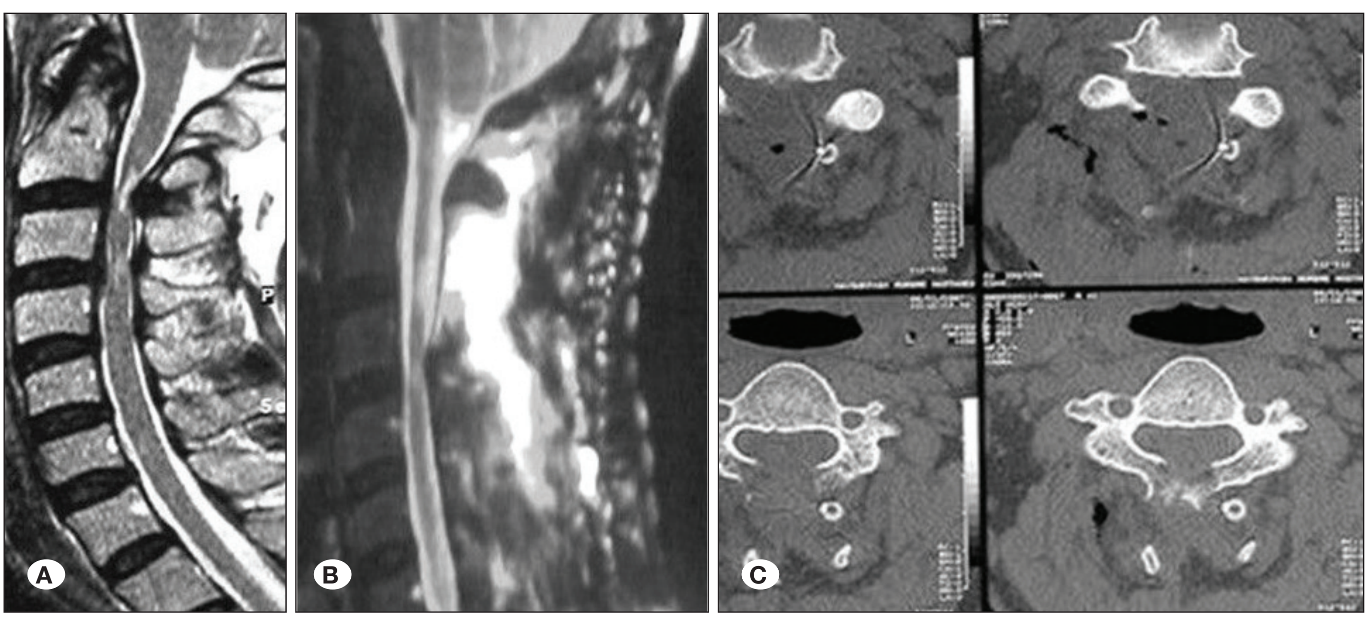

Figure 5: A) Preoperative T2W sagittal MRI sections. **B)** Satisfactory C2 total and C3 partial laminectomy and total neural decompression are observed in the T2W sagittal MRI. **C)** Satisfactory C2 total and C3 partial laminectomy sites are seen in the axial CT images.

Sagittal spinal canal narrowing is the primary degenerative pathophysiological process leading to cervical spondylosis. This process may also result in secondary compressive and vascular lesions. Researchers have suggested that most patients with spinal canal diameters below 14.8 mm are at risk of cervical spondylotic myelopathy (13,39).

Some studies have also suggested that spinal cord damage or spinal vascular compression may occur due to degeneration of the cervical spine in patients with cervical spondylosis (33,35). This neural and vascular process has been reported to cause neurological symptoms in patients with cervical spondylotic myelopathy (33). Clinical examinations have revealed that patients with cervical spondylosis complain of neck pain, radiculopathy, and myelopathy due to the compression of neural structures (29,34).

In the present study, 17 patients presented to the clinic with complaints of pain and numbness, 12 patients had arm and leg weakness, and three patients had gait disturbance. The average early postoperative recovery rate was 82.4% in patients with cervical spondylosis who presented with pain symptoms. This rate was statistically significantly higher ($p<0.05$) in patients who presented with weakness or gait disturbance.

Neurological improvement is lower in patients 70 years or older who have undergone operations for the treatment of cervical spondylotic myelopathy (32). In the present study, the postoperative mJOA recovery scores of patients aged 71 years were lower than those in the 20–50 and 50–70 age groups. This finding is in line with the literature. The Torg-Pavlov ratio < 1.00 demonstrated a linear correlation between congenital spinal stenosis and cervical stenosis (6,12). The Torg-Pavlov ratio values in this study's patient group (n=28) with myelopathy requiring surgical decompression were compared with those in the control group (n=88) who presented with neck pain but did not have any clinical evidence of neurologic deficits (46). The Torg-Pavlov ratio values in the control group were 0.95 ± 0.14, while those in the study group were 0.72 ± 0.08 (46). The Torg-Pavlov ratio values were < 1.00 in 29 (91%) out of 32 patients in the present study. The Torg-Pavlov ratio values were lower in the 20–50 age group.

A spinal canal anteroposterior diameter ≤ 13 mm on a plain lateral radiograph in a neutral position is considered to be an indication of cervical spondylosis (10,24). The distance from the midpoint of the posterior corpus to the closest point of the arcus is used to measure the sagittal canal diameter. The average distance from C3 to C7 was 17 ± 5 mm (31). Normal cervical spinal canal size is 17.6–18 mm in European people and 15–17 mm in Japanese people (26). A spinal canal narrower than 12 mm has been reported to cause earlier clinical cervical spondylosis (26).

In the present study, the patients' average spinal canal size was 9 mm. The number of patients with a spinal canal diameter ≥ 11.1 mm was higher in the 20–50 years age bracket (85.7%), while those with a spinal canal diameter between 7–9 mm was higher in the ≥ 71-year-old bracket (75%).

The correlation between neurological recovery and the presence of myelomalacia in cervical spine MRI is controversial. Some studies have suggested that there is a correlation between the presence of myelomalacia and postoperative neurological recovery (14), while others have reported no correlation between myelomalacia and the clinical picture (27). The present study's findings reveal no significant correlation between myelomalacia and pre-and postoperative neurological pictures.

The degenerative process of spondylosis may cause a loss of height, mostly in the disc gaps. This height loss occurs initially in the anterior part of the intervertebral disc. The height of the anterior disc distance is greater than that of the posterior disc distance. This condition contributes to normal physiologic cervical lordosis. The average cervical lordosis angle is 14.4^0 (5). As the ventral body height decreases, the lordotic posture straightens and disappears. This straightening increases the force applied to the ventral side of the vertebral bodies, which leads to the loss of height. The collapse of the disc space and vertebral corpus causes forceful forward bending of the dural sac and cord. An accurate evaluation of the spinal curvature is relevant to the choice for the choice of surgical procedures. In active cervical kyphosis, any dorsal parts of the vertebral corpus from C3 to C7 cross the line drawn in the midsagittal plane from the dorsocaudal aspect of the vertebral body of C2 to the dorsocaudal aspect of the vertebral body of C7.

The vertebral bodies from C3 to C7 do not cross this line in cervical lordosis. The straightening of the cervical body is considered if it is unlikely to determine whether kyphosis or lordosis is present in the midsagittal region. An assessment of spine geometry is effective in selecting the appropriate surgical approach. The angle formed by the intersection of parallel lines drawn on the posterior surface of C2 and C7 on cervical direct radiography can be described as the cervical lordosis angle (5).

To administer the best treatment method for cervical spondylosis, the etiopathology and biomechanics of the disease, the clinical picture, and the radiological findings should be known. The patient's age, localization of spinal cord compression, cervical alignment parameters, number of involved cervical segments, hyperintensity in the spinal cord, and normal and abnormal movements of the neck should also be evaluated carefully to select the appropriate surgical procedure. In the present study, the patients were divided into three groups according to the preferred surgical approach. The increase in the postoperative lordosis angles compared to the preoperative lordosis angles in the first group patients (anterior corpectomy and fusion) was statistically significant compared to patients in the second group (laminectomy) and the third group (laminectomy and stabilization) ($p<0.05$). Administering posterior approaches to patients with straightening of cervical lordosis or kyphotic deformity may aggravate kyphotic deformity and turn straightened lordosis into kyphosis or may not provide sufficient decompression in the spinal cord.

The effect of the selected surgical approach on postoperative neurological recovery is controversial. In this study, the increased mJOA score was statistically significant in the first group of patients treated with the anterior approach and in the second group of patients treated with posterior laminectomy ($p>0.05$). The increase in the postoperative mJOA score was not statistically significant in the third group of patients who underwent posterior laminectomy with stabilization ($p>0.05$).

In a study by Yang et al. (40), 58 patients underwent surgical treatment with an anterior approach, and 67 patients underwent treatment with a posterior approach. The authors reported no statistically significant increase in postoperative mJOA score. Sakaura et al. reported no statistically significant difference in the mJOA scores of patients operated on using anterior and posterior approaches (32).

Wang et al. treated 60 patients with a two-level anterior cervical discectomy and fusion (37). Twenty-eight patients underwent fusions without plates, and 32 underwent fusions with plates. The authors reported that no patients treated with plates had pseudarthrosis and that 25% of those treated without plates had pseudarthrosis throughout the 2.7-year follow-up period. In another study, 22 patients underwent single-level corpectomy, and 36 underwent multilevel corpectomy. Comparing preoperative and postoperative mJOA scores and neurophysiological values, the authors suggested that single-level or multilevel corpectomy methods are effective and safe surgical intervention procedures for the treatment of cervical spondylosis (30).

Laminectomy, a method used in the management of cervical spondylosis due to the ossification and hypertrophy of the posterior cervical structures, can be performed at one or more distances, depending on the level of stenosis. Special care should be taken during dissection not to cut the muscle insertions, which may damage the erector structure of the neck. Laminas are cut vertically with a high-speed burr from the points where they attach to the facet joint. The ligamentum flavum is then cut at its most proximal and distal parts, completing the laminectomy. Care should be taken to protect the facet joint capsule during laminectomy, or movement limitations caused by auto fusion may be seen in the follow-up period. Laminectomy should not be performed in the presence of preoperative kyphosis.

Hadra (11) first described posterior cervical stabilization in 1891 as a technique that consisted of tying spinous processes using wires. Subsequently, Holness et al. developed the interlaminar clamping method in 1984 (15). The method of treating posterior cervical instability changed completely with the development of plate-screw fixation systems. The lateral mass plate-screw system provides rapid internal stabilization. However, spinal fusion is also necessary to prevent instability from occurring in the long term (15).

Lateral mass instrumentation may eliminate the risk of postoperative kyphosis following total laminectomy in patients with cervical spondylosis; it is useless to perform lateral mass instrumentation in the presence of cervical kyphosis. Lateral mass instrumentation is also contraindicated in patients with poor bone quality, such as those with osteoporosis, osteomalacia, and osteopenia. To successfully perform lateral mass plate-screw fixation, the plate should be shaped, appropriate screws should be selected and tightened, and the system should be set after the lateral mass is drilled. Many techniques of screw fixation have been described in the literature.

Gargiulu et al. (9) evaluated 42 patients with cervical spondylotic myelopathy. Nineteen patients underwent cervical laminectomy, and 23 underwent laminectomy and instrumentation with a lateral mass screw. Then, preoperative and postoperative Nurick scale, VAS, C2-C7 SVA, T1 slope, C2-C7 lordosis, and JOA scores were assessed. The authors suggested that both surgical procedures have advantages and disadvantages and are effective in the treatment of patients with cervical spondylotic myelopathy (9).

The approaches used for patients with indications for surgery are anterior (discectomy and osteophytectomy ± fusion, central corpectomy, and fusion, anterolateral decompression, oblique corpectomy ± fusion), posterior (laminectomy, laminoplasty, laminectomy + fusion with lateral mass screw), or combined. The anterior approach should be preferred in patients with cervical spinal malalignment, such as straightening of cervical lordosis or kyphotic deformity. Combined posterior stabilization is recommended for corpectomy higher than three levels. Multilevel anterior corpectomy and posterior instrumentation after fusion are recommended for patients with severe cervical stenosis. If there is no kyphotic deformity or straightening of the cervical lordosis, laminectomy can be performed to avoid the long-term complications of an anterior corpectomy. A wide and large laminectomy can result in segmental instability.

Animal subjects have rarely been used in previous studies. The sensitivity of animal tissue is known to differ from that of human tissue (43,44), so results obtained from animal tissue assays may diverge from those using human tissues, which may produce misleading outcomes (43,44). For this reason, we believe the results of this research will be valuable.

The present study has a number of limitations, including its retrospective design. A second limitation is the study's inclusion of quite a few patients in all surgical groups.

CONCLUSION

Cervical spondylosis is a progressive degenerative disease that affects all components of the spine. Many surgical procedures are used to treat patients with cervical spondylosis, but there is no consensus on which surgical procedure is the safest and most effective. Preoperative clinical and radiological assessments are vital in selecting the appropriate surgical method. Detailed clinical and radiological examinations should be performed before and after surgical intervention to choose a treatment and evaluate its effectiveness. Scoring systems and detailed analyses of cervical alignment parameters developed for clinical evaluation should be widely used in practice.

AUTHORSHIP CONTRIBUTION

Study conception and design: HS, BAB

Data collection: HS, BAB

Analysis and interpretation of results: NK

Draft manuscript preparation: NK, MZB

Critical revision of the article: NK

Statistical evaluations: NK

All authors (HS, BAB, NK, MZB) reviewed the results and approved the final version of the manuscript.

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