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Research

Evaluation of Cervical Lordosis Loss in Patients Undergoing Posterior Cervical Laminectomy Without Instrumentation

Enstrümantasyon Uygulanmayan Posterior Servikal Laminektomi Hastalarında Servikal Lordoz Kaybının Değerlendirilmesi

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ABSTRACT

Objective: Various surgical techniques, including ventral and dorsal approaches, exist for cervical spondylotic myelopathy (CSM). We present the results in patients with CSM who underwent cervical laminectomy without fusion. Our aim was to remind readers of the advantages of this nearly forgotten technique.

Methods: Our study is a single-center, non-randomized, retrospective observational study. Our study was carried out in University of Health Sciences Türkiye, Bakırköy Prof. Dr. Mazhar Osman Training and Research Hospital between 01.01.2013 and 31.12.2022. In our study, we included patients admitted to the neurosurgery inpatient service who underwent posterior cervical laminectomy without fusion.

Results: Between 2013 and 2022, 24 patients underwent posterior cervical laminectomy without fusion. Neurological improvement was observed in 16 patients. No major complications were experienced in any of the 24 cases. Preoperative C2-7 Cobb angles averaged 15.75 degrees. At the 1 year follow-up, the mean C2-7 Cobb angle was 10.25 degrees.

Conclusion: Cervical laminectomy without fusion can be a suitable, low-complication, and easily applicable alternative to other techniques for the appropriate patient group.

Keywords: Brain and nerve surgery, cervical spondylotic myelopathy, cervical laminectomy

ÖZ

Amaç: Servikal spondilotik myelopatide (SSM) ventral ve dorsal olmak üzere çeşitli ameliyat teknikleri mevcuttur. SSM'de füzyonsuz sadece servikal laminektomi yaptığımız hastaların sonuçlarını sunduk. Artık daha az tercih edilen bu tekniğin avantajlarını hatırlatmayı amaçladık.

Gereç ve Yöntem: Çalışmamız tek merkezli, randomize olmayan, retrospektif ve gözlemsel bir çalışmadır. Çalışmamız Sağlık Bilimleri Üniversitesi, Bakırköy Prof. Dr. Mazhar Osman Ruh Sağlığı ve Sinir Hastalıkları Eğitim ve Araştırma Hastanesi'nde 01.01.2013-31.12.2022 tarihleri arasında gerçekleştirildi. Çalışmamıza nöroşirürji servisine yatırılan ve füzyon yapılmadan posterior servikal laminektomi uygulanan servikal spondilotik miyelopati hastaları dahil edildi.

Bulgular: 2013 ve 2022 yılları arasında 24 hastaya füzyonsuz posterior servikal laminektomi uygulandı. On altı hastada nörolojik iyileşme gözlemlendi. Yirmi dört olguda majör komplikasyon yaşanmadı. Ameliyat öncesi C2-7 Cobb açıları ortalama 15,75 derece olarak ölçüldü. Bir yıllık takipte, C2-7 Cobb açıları ortalama 10,25 derece olarak ölçüldü.

Sonuç: Füzyonsuz sadece servikal laminektomi uygun hasta grubunda diğer tekniklere göre uygun ve kolay uygulanabilir bir alternatif olabilir.

Anahtar Kelimeler: Beyin ve sinir cerrahisi, servikal spondilotik myelopati, servikal laminektomi

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INTRODUCTION

Cervical spondylotic myelopathy (CSM) is a complex syndrome characterized by chronic compression and ischemia of the spinal cord, and by pathologies of the spinal canal and spine (1). CSM is characterized by the progressive loss of integrity and function of the cervical cord (2). It is characterized by specific symptoms and clinical findings, depending on the location and severity of spinal cord damage. It presents with symptoms and findings such as decreased manual dexterity, impaired balance, reduced muscle strength in the extremities, and urinary dysfunction (3). Magnetic resonance imaging can detail the location and extent of the damage (2).

In severe cases, surgery appears to be the best option (4). Approximately half of patients initially managed non-surgically undergo surgery because of worsening symptoms (4). During follow-up, 23%-54% of patients who were not initially recommended for surgery underwent surgery within 70 months (4).

Both anterior and posterior techniques can be applied in surgical treatment. Different techniques within the anterior and posterior approaches can be beneficial for surgical treatment. Cervical posterior laminectomy, laminoplasty, and full endoscopic techniques are associated with favorable outcomes (5). Therefore, there is no consensus on the surgical technique for CSM.

Our aim is to report neurological improvement and C2-7 Cobb angle values at 1 year after surgery in patients who underwent posterior cervical laminectomy without fusion. We planned to measure and compare the preoperative and postoperative C2-7 Cobb angles.

METHODS

Patient Population

Our study is a single-center, non-randomized, retrospective, and observational study. Our study was carried out in University of Health Sciences Türkiye, Bakırköy Prof. Dr. Mazhar Osman Training and Research Hospital between 01.01.2013 and 31.12.2022. In our study, we included patients who were admitted to the neurosurgery inpatient service and underwent posterior cervical laminectomy without fusion.

From hospital records, the patients' genders, ages, complaints (such as decreased manual dexterity, loss of balance, loss of muscle strength in the extremities, and urinary dysfunction), and physical examination findings were recorded. Findings from preoperative cervical computed tomography, cervical X-rays (anteroposterior and lateral), and magnetic resonance imaging were retrieved from the hospital's electronic database. Postoperative cervical X-ray and magnetic resonance imaging findings were also obtained from the hospital's electronic database.

Cervical X-rays taken during the patients' monthly and annual follow-ups were obtained from the hospital's electronic records. Visual analogue scale (VAS) scores used to assess pain in all patients who underwent surgery at our hospital were extracted from patients' discharge summaries. Recorded VAS scores for neck pain and sensory problems were extracted from hospital records.

All procedures conducted in studies involving human participants adhered to the ethical guidelines set forth by the institutional and/or national research committees and were in accordance with the 1964 Declaration of Helsinki and its subsequent amendments or equivalent ethical standards. This study received approval from the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (approval no: 2024-09-11, date: 02.09.2024). Informed consent was not required because the study was retrospective.

Surgical Technique

A routine posterior cervical surgical approach was performed using a midline incision at the necessary levels. Paravertebral muscles were dissected from the spinous processes using cautery. Muscle tissue over the lateral mass was preserved (Figure 1). Laminectomies were performed using Kerrison rongeurs, numbers 1 and 2. Facet resection was not performed. After decompression was achieved, hemostasis was performed. A drain was placed, and the anatomical layers were sutured appropriately.

Radiological Measurements

C2-7 Cobb angles were measured by a single physician, a neurosurgeon with 25 years' experience in spine disorders, using the hospital's electronic database. The Cobb angle values were remeasured from the electronic database preoperatively and 1 year postoperatively.

Statistical Analysis

IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Normally distributed data were presented as mean±standard deviation, whereas non-normally distributed data were presented as median (min-max). When comparing preoperative and postoperative data, the paired t-test was used for normally distributed data, and the Wilcoxon test was used when at least one dataset was not normally distributed. A significance level of 0.05 was adopted.

Inclusion and Exclusion Criteria

Only patients who underwent posterior cervical laminectomy for CSM were included in the study. Patients who underwent laminoplasty or lateral mass instrumentation were excluded. Patients without preoperative cervical X-rays were excluded. Patients who did not attend postoperative follow-ups were excluded from the study. Patients without cervical X-rays at 1 year postoperatively were excluded. Those who had two or more neck surgeries were not included in the study.

RESULTS

Demographic Findings

Between 2013 and 2022, 24 patients underwent posterior cervical laminectomy without fusion (Figures 1 and 2). There were 8 female (33.3%) and 16 male patients. The average age of the patients was found to be 59.25±11.80. Cervical laminectomy was performed at a mean of 2.62±0.85 levels. Neurological improvement was observed in 16 patients (66.6%). Complaints and findings are presented in Table 1.

Changes in Neck Pain and Cobb Angles

Preoperative C2-7 Cobb angles were measured at an average of 15.75 degrees. At the 1-year follow-up, the C2-7 Cobb angle averaged 10.25° (Figures 3 and 4). After surgery, C2-7 Cobb angles were significantly reduced compared with preoperative values (p=0.001, paired-samples t-test).

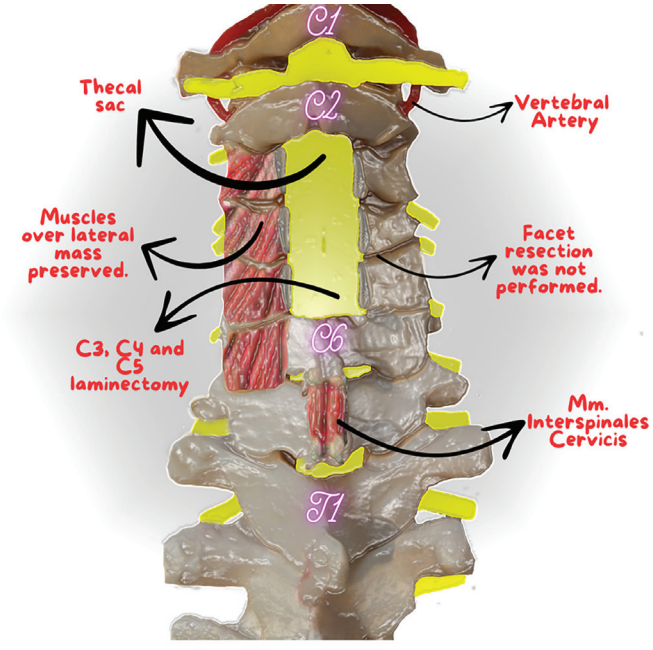

Figure 1. The muscles over the lateral mass were preserved. Facet resection was not performed. The technique of cervical laminectomy without fusion has been illustrated

However, we did not have any patient who developed cervical kyphosis. VAS scores before and after treatment are presented in Figure 5. Neck VAS scores were significantly reduced after treatment compared with before treatment (Wilcoxon test, p<0.001).

DISCUSSION

Posterior cervical laminectomy without fusion was performed on 24 patients (Figures 1 and 2). Our rate of neurological improvement is 66.6% (n=16). Arnold et al. (6) reported improvement rates of 52% for patients who underwent laminectomy and 83% for patients who underwent laminectomy plus fusion (5/6 patients). Carol and Ducker (7) reported long-term improvement rates of 68% in the patient group who underwent posterior laminectomy.

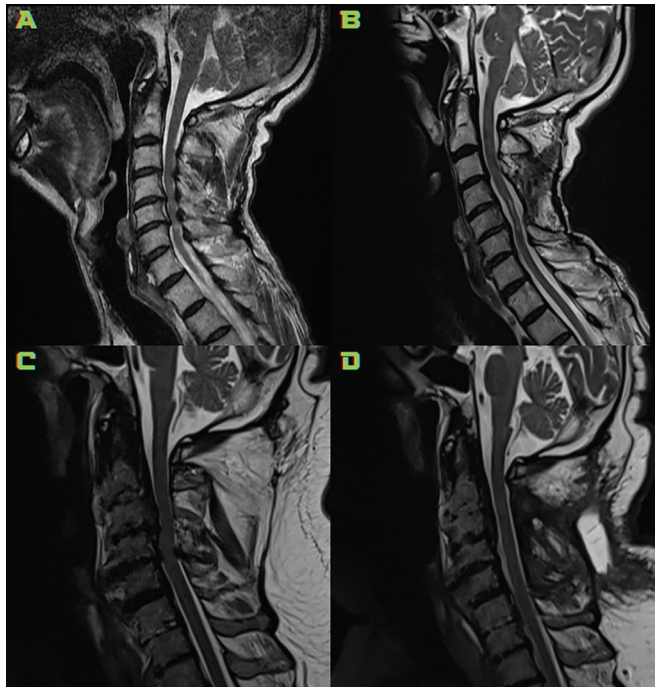

Figure 2. The preoperative and postoperative MRI images of 2 patients with cervical spondylotic myelopathy undergoing cervical laminectomy without fusion are shown
MRI: Magnetic resonance imaging

Table 1. The complaints and findings of the patients

Variables	n (percentage or standard deviation)
Motor deficits	21 (87.5%)
Upper motor neuron signs	17 (70.8%)
Sensory abnormalities	16 (66%)
Incontinence	3 (12.5%)
Impairment of gait and/or falls	18 (75.0%)
Decreased fine manual skills	16 (66.6%)

They reported long-term improvement rates of 73% in their series of patients who underwent anterior cervical discectomy and fusion (7). Ebersold et al. (8) reported long-term recovery rates of 37% following posterior laminectomy and 55% following anterior cervical intervention. Compared with studies published before 2000, our neurological

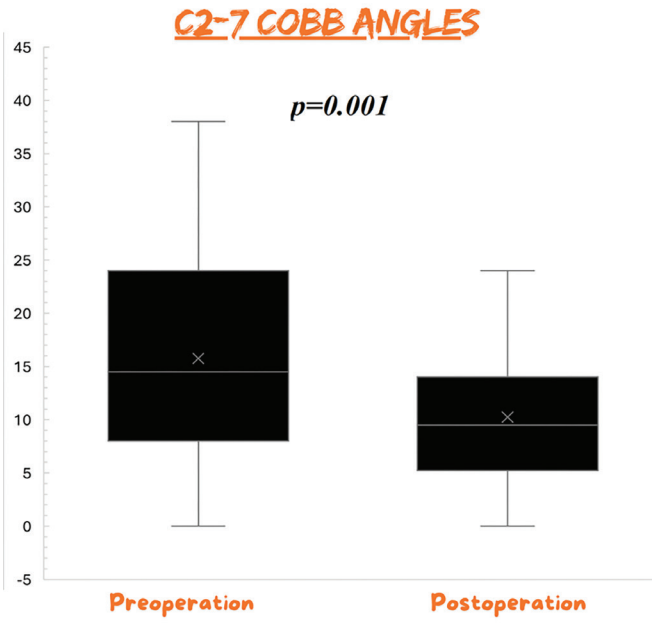

Figure 3. After surgery, Cobb C2-7 angles were significantly reduced compared to before treatment (p=0.001) (paired samples t-test)

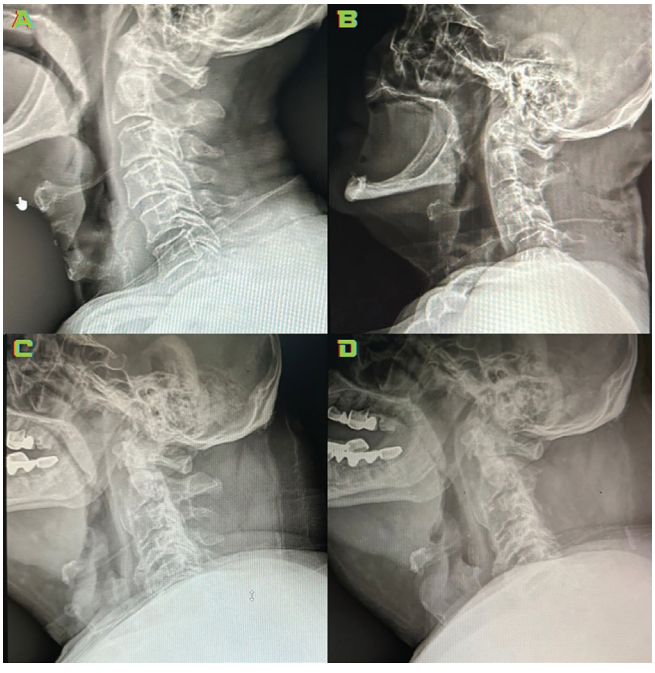

Figure 4. Preoperative Cobb C2-7 angles were measured at an average of 15.75 degrees. At the 1-year follow-up, Cobb C2-7 angles were measured at an average of 10.25 degrees

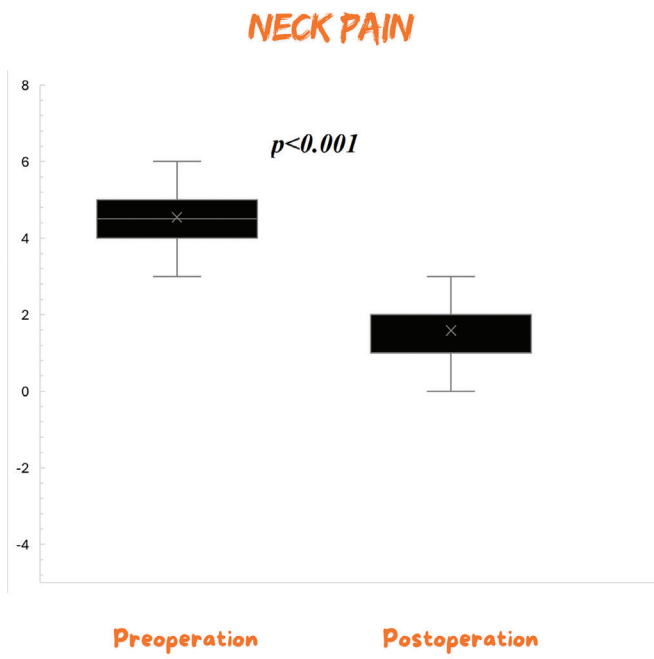

Figure 5. Neck VAS scores after treatment were significantly reduced compared to before treatment (p<0.001) (Wilcoxon test)
VAS: Visual analogue scale

improvement rate (66.6%) following posterior cervical laminectomy without fusion appears more favorable.

This may be due to increased knowledge, preservation of muscle tissue over the lateral mass, avoidance of facetectomy, and use of a microscope (Figure 1). Sakaura et al. (9) reported improvement rates (evaluated with Japanese Orthopedic Association) of 71% in the group who underwent the anterior approach and 70% in the group who underwent laminoplasty. The improvement rate in our study (66.6%) is consistent with that reported by Sakaura et al. (9).

Pathophysiology of Cervical Spondylotic Myelopathy

CSM results from chronic cord compression due to degenerative changes in the intervertebral discs, the facet joints and the uncovertebral joints, and associated ligamentous hypertrophy. The resulting canal narrowing causes ischemia, demyelination, and neuronal loss (10-12). The zygapophyseal joint also absorbs multidirectional compressive, shearing, and torsional forces (13,14). The Luschka joint functions in concert with the facet joint. It assists in lateral bending and rotational movements. It restricts cervical spine movements that exceed its physiological or anatomical limits and could therefore be considered pathological (15,16). This complex anatomical structure is accompanied by fibrotic ligaments that connect different regions (10). Particularly, the anterior longitudinal ligament, posterior longitudinal ligament, interspinous ligament,

ligamentum flavum, and capsular ligaments contain elastin and collagen. The functions of these units depend on their anatomical localization and biochemical composition, such as elastin and collagen. They are resistant to normal and abnormal loads (10).

Across studies, the average loss of lordosis is 5 degrees even after laminoplasty (17,18). In our study, the average lordosis loss was 5 degrees (Figure 3). It is consistent with previous studies. In fact, given the nature of the surgical technique (a procedure in which no fusion is performed), it can be considered a more favorable outcome.

Surgical Options or Preferences in Cervical Spondylotic Myelopathy

The results of studies comparing anterior and posterior approaches, the latter with or without fusion, are inconclusive (19,20). Surgical techniques include ventral decompression and fusion; multilevel discectomy and plating; corpectomy; posterior fusion using lateral mass or pedicle screws; various laminoplasty techniques; and posterior cervical laminectomy without fusion (20-23). In the United States, posterior fusion surgeries increased until 2002, and expenditures exceeded $2 billion (20).

Both anterior and posterior surgical techniques are associated with effective improvements (20,21). Among posterior surgical techniques, laminoplasty or laminectomy combined with posterior fusion is used (24). In our study, we presented the results of cases in which posterior cervical laminectomy without fusion was performed. Some authors reference Albert and Vaccaro's (23) 1998 paper, stating that posterior cervical laminectomy without fusion can lead to complications, such as post-laminectomy kyphosis (24). We believe this situation is misinterpreted. Albert and Vaccaro (23) specifically noted that the rates of post-laminectomy kyphosis are higher in children due to the immaturity of their musculoskeletal system. However, they state that in adults the rates of post-laminectomy kyphosis are low when preoperative cervical alignment is normal and there is no instability (23). They state that aggressive muscle dissection, unnecessary facet resection, age, and preoperative kyphosis can lead to post-laminectomy kyphosis (23). If the patient has kyphosis, the following can be applied: anterior decompression with fixation, and pedicle screw system fixation with decompression (22,25). Small or insufficient pedicles, abnormal pedicle axis, preoperative posterior cervical infection, and abnormal vertebral artery positions are dangerous and constitute contraindications to posterior fusion (22). If the outer diameter of the cervical pedicle is less than 4 mm, safe screw placement is considered technically infeasible (22). Moreover, during posterior cervical instrumentation, degeneration of the lateral mass can make determining the entry point difficult (22). Karaikovic et al. (26) also noted that there is no safe zone in the anterior parts of the C3-C7 cervical vertebral bodies. Prior to posterior instrumentation, the vertebral artery anatomy and its variations should be evaluated in detail (22,27). Neurovascular structures should be evaluated individually (22,27). Although Abumi (22) noted that posterior cervical instrumentation with pedicle screw fixation is a strong method for correcting cervical deformity, he also stated that it can cause neurovascular complications. Cases of cerebral infarction due to posterior cervical instrumentation have also been reported in the literature (28). Brachial plexus injury is also a complication that can develop from positioning (22). Abumi (22) states that pedicle screw fixation provides stronger stabilization than other internal fixation methods. However, he notes that even experienced and careful surgeons have relatively high rates of screw malposition and neurovascular complications (22).

Lau et al. (24) demonstrated that laminectomy combined with spinal fusion results in greater blood loss than laminoplasty. Laminectomy with spinal fusion resulted in longer hospital stays than laminoplasty. Laminectomy with posterior spinal fusion was associated with more long-term complications than laminoplasty (24). However, laminectomy with posterior spinal fusion (pedicle screw or lateral mass) was associated with greater neurological improvement than laminoplasty (24,25). Reports indicate that dorsal laminoplasty showed greater improvement on the short form-36 (SF-36) at 1 year compared with dorsal and ventral fusion (20). No statistically significant difference was found in postoperative neck pain between the two groups. However, when fixation is performed with lateral mass screws, there is a risk of iatrogenic nerve root compression if preoperative foraminal stenosis is present (22,29,30). Excessive traction on the shoulder girdle during C-arm projection can also cause brachial plexus palsy (22). A considerably more invasive technique, combined pedicle-screw instrumentation at C2 and C7 with lateral-mass instrumentation at C3-C6, is technically demanding and laborious (22).

Piazza et al. (19) reported that posterior laminectomy produced greater radiological decompression and expansion of the posterior cerebrospinal fluid space than anterior cervical discectomy. However, they included both fusion and non-fusion patients in the same posterior group, without dividing them into two distinct groups (19). They showed that the posterior approach is better when ligament hypertrophy predominates in posterior spinal cord compression (19). Dorsal surgery for CSM produced greater improvements in physical functioning than ventral surgery

at 1 and 2 years (20). Lawrence et al. (31) also stated that laminoplasty provided sufficient decompression. In terms of infection rates and postoperative pain syndromes, anterior approaches appear to be superior (19). Ghogawala et al. (20) reported that ventral surgery was associated with a higher risk of complications (dysphagia, reoperation, readmission within 1 month) and of new neurological deficits. Nunna et al. (32) compared posterior decompression and fusion to anterior discectomy and fusion and reported different outcomes. In the posterior fusion group, they found higher rates of complications , including urinary tract infection, deep vein thrombosis, pulmonary embolism, infarction, wound dehiscence, surgical site infection, readmission, revision surgery, and pseudoarthrosis (32). In patients who underwent posterior fusion, the use of narcotic medications was also found to remain high for up to 120 days (32).

In cervical laminoplasty, which is less invasive than other techniques, complications such as spinal cord injury, infection, readmission within 30 days, and fever of unknown origin have been reported (20). The rate of C5 palsy in patients who underwent cervical laminoplasty was reported to be 2.4% (33). Morishita et al. (34) reported the following systemic complications in a large series of patients who underwent laminoplasty: cardiovascular disease, cerebrovascular disease, respiratory failure, pneumonia, dysphagia, renal failure, hepatic failure, gastric ulcer and hemorrhage, deep venous thrombosis, pulmonary embolism, sepsis, and delirium. In the same study, local complications such as surgical site infection, paralysis, meningitis, spinal fluid leakage, and hematoma were also reported (34).

The surgical technique is closely related to the types and variety of complications (20). It remains unclear which technique is optimal for the treatment of CSM (20,22,24,25). Moreover, complication rates and types vary and may even be contradictory depending on the surgical technique (19,20,22,23,32-34). In our opinion, among the various techniques, posterior cervical laminectomy without fusion is the least invasive. In our study, no minor or major complications occurred. Although the decrease in the C2-7 Cobb angle is significant (Figure 3), posterior cervical laminectomy without fusion offers many advantages. These advantages include being less invasive than other surgical approaches, avoiding the potential risks associated with instrumentation, having a shorter operative time, having a lower risk of immediate postoperative complications, and being technically easier than other surgical approaches.

Finally, we would like to note an additional consideration. In patients with advanced spondylotic change—where substantial osteophytic formation (Figure 6) has already contributed to a degree of auto-stabilization—we do not consider routine application of further instrumentation necessarily advantageous. While this observation should be interpreted cautiously, it reflects our clinical impression that, in selected cases, additional fixation may offer limited benefit relative to its potential risks.

Study Limitations

Our study has some scientific limitations. The most significant limitation is its retrospective nature. Additionally, the number of patients was limited. The patients' histories, comorbidities, and physical examination data may not have been adequately documented. In our clinic, examinations such as the hyperactive pectoralis reflex, the inverted radial reflex, the positive finger escape sign, and the release test were not recorded. Tests assessing quality of life, such as the SF-36, were not administered preoperatively or postoperatively. This makes it difficult to evaluate the impact of the results on patients' quality of life. A one-year follow-up period may not provide sufficient information about long-term results and complications. The lasting

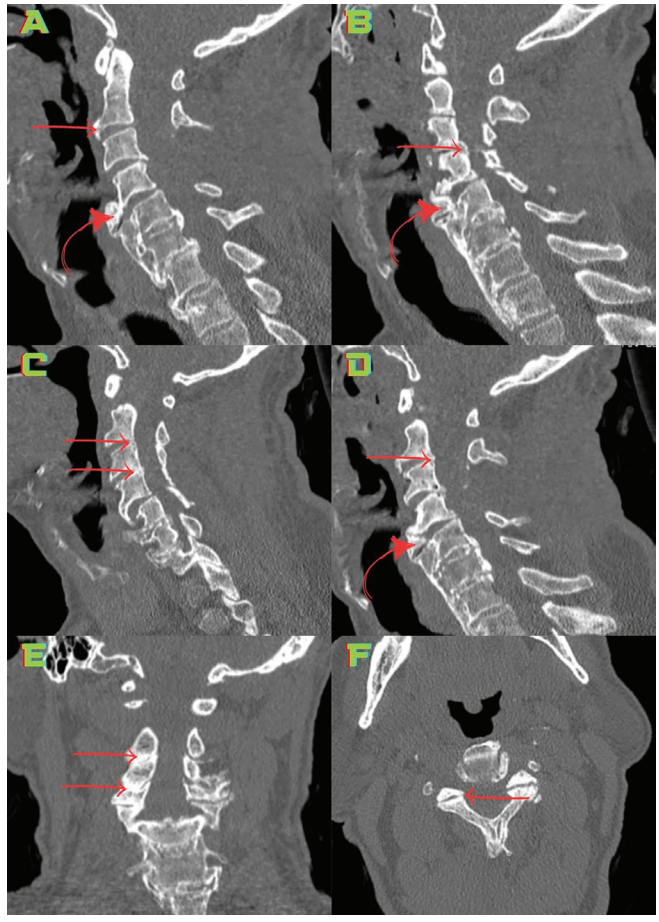

Figure 6. A cervical spine attempting to stabilize itself with osteophytosis is being observed

effects of the method can be evaluated with longer-term follow-up studies.

CONCLUSION

CSM is a serious condition that significantly affects patients' quality of life and is characterized by progressive neurological deficits. For treatment, surgery is preferred to conservative therapy. Among the surgical techniques are ventral decompression and fusion, multilevel discectomy with plating, corpectomy, posterior fusion with lateral mass screws, posterior fusion with pedicle screws, various laminoplasty techniques, and laminectomy without fusion. A posterior cervical laminectomy without fusion can be a suitable and readily applicable alternative to other techniques for the appropriate patient group. One of its advantages is lower complication rates.

ETHICS

Ethics Committee Approval: This study received approval from the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (approval no: 2024-09-11, date: 02.09.2024).

Informed Consent: Informed consent was not required because the study was retrospective.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: Ö.E.S., A.E.T., Concept: Ö.E.S., Design: Ö.E.S., A.E.T., Data Collection or Processing: Ö.E.S., Analysis or Interpretation: A.E.T., Literature Search: Ö.E.S., A.E.T., Writing: Ö.E.S., A.E.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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