ORIGINAL ARTICLE

Outcome of cervical cases operated with posterior cervical pedicle screw placement: a single-center retrospective study

Ali Borekci, Pınar Kuru Bektaşoğlu, Erhan Çelikoğlu

Department of Neurosurgery, University of Health Sciences, Fatih Sultan Mehmet Education and Research Hospital, İstanbul-*Türkiye*

ABSTRACT

BACKGROUND: Cervical pedicle screws offer biomechanical advantages over other stabilization systems. However, their placement carries a relatively high risk of vascular or neurological injury due to individual differences and the complex structure of the cervical spine. Therefore, understanding patient-specific anatomy is crucial for the safe and accurate placement of pedicle screws. In this study, we present our single-center case series over a seven-year period involving cervical pedicle screw placement in subaxial cases.

METHODS: We retrospectively analyzed patients who underwent cervical subaxial pedicle screw placement between 2017 and 2024. A freehand surgical technique was employed, using a mini-laminotomy approach to ensure safe screw placement. During the procedure, the medial, superior, and inferior borders of the pedicle were palpated.

RESULTS: A total of 70 cases were analyzed retrospectively. Fifty patients were male, and 20 were female. The patients ranged in age from 20 to 89 years (median age: 64 years). Fifty-seven patients (81.5%) had cervical stenosis as the surgical indication. Of the remaining cases, 11 patients had fractures and two had tumors. Among the 468 pedicle screws placed, 434 were graded as 0-1. The correct placement rate was 92.7%. Thirty-four screws were malpositioned (grade 2-3), representing a rate of 7.3%.

CONCLUSION: In our case series, the accuracy of cervical subaxial pedicle screw placement was high. We believe that achieving this level of accuracy requires a strong understanding of anatomy, three-dimensional spatial awareness, and surgical experience.

Keywords: Cervical subaxial pedicle screw; cervical spondylotic myelopathy; cervical trauma; cervical tumor.

INTRODUCTION

Cervical spondylotic myelopathy, cervical trauma, and cervical tumors are among the most common indications for posterior cervical fusion surgery. In many of these cases, surgeons encounter distorted anatomy, which compromises the accuracy and safety of cervical pedicle screw insertion. For individuals with segmental instability, local kyphosis, or previously operated cervical spine disorders, combined posterior decompression and reconstruction is beneficial.[1]

Due to their superior biomechanical properties compared to other methods, cervical pedicle screws are increasingly used in cervical spine fusion surgery.[2] However, the technique carries a relatively high risk of vascular or neurological injury due to individual anatomical variations and the complex architecture of the cervical spine.[3]

Modern navigation systems can improve pedicle screw accuracy, but they also have limitations. The shift can introduce errors, and the cost of the technology remains high. Ito et al.[4] reported a 97.2% Grade I accuracy rate using 3D fluoroscopy-assisted cervical pedicle screw insertion, which is an ideal outcome. However, this technology is not available

Cite this article as: Borekci A, Kuru Bektaşoğlu P, Çelikoğlu E. Outcome of cervical cases operated with posterior cervical pedicle screw placement: A single-center retrospective study. Ulus Travma Acil Cerrahi Derg 2025;31:798-803.

Address for correspondence: Pınar Kuru Bektaşoğlu

Department of Neurosurgery, University of Health Sciences, Fatih Sultan Mehmet Education and Research Hospital, İstanbul, Türkiye

E-mail: drpinarkuru@gmail.com

Ulus Travma Acil Cerrahi Derg 2025;31(8):798-803 DOI: 10.14744/tjtes.2025.83686

Submitted: 17.11.2024 Revised: 01.07.2025 Accepted: 11.07.2025 Published: 05.08.2025

in every operating room, and the issue of radiation exposure is still unresolved. Therefore, understanding patient-specific anatomy is essential to improving accuracy in pedicle screw placement, particularly in the cervical area.[5] More feasible alternative methods have been described in the literature, such as detailed preoperative planning based on patient-specific anatomy[6] and 3D modeling, which may also help reduce radiation exposure.[2]

In this study, we aimed to present our single-center case series over a seven-year period involving cervical subaxial pedicle screw placement using the freehand technique.

MATERIALS AND METHODS

We retrospectively analyzed patients who underwent cervical pedicle screw placement in our clinic between April 2017 and May 2024. Local ethical committee approval was obtained (FSMEAH-KAEK 2021/37). The study was conducted in accordance with the Declaration of Helsinki. After April 2022, the senior neurosurgeon began using a surgical microscope for pedicle screw placement. Forty-one cases were performed without a microscope, and 29 were performed using a surgical microscope. The surgical technique followed the method we previously published.[7] The authors used a freehand surgical technique to place the cervical pedicle screws. This involved a mini-laminotomy approach to palpate the medial trajectory of the pedicle and guide screw placement. The entry point for the pedicle screw was 1-2 mm lateral to the midpoint of the superior articular process. The mini-laminotomy technique enabled the surgeon to feel the medial trajectory of the pedicle. Grading of the pedicle screws was based on previously published criteria:[7]

- Grade 0: Screw entirely within the pedicle walls,
- Grade 1: Less than 25% of the screw penetrated the pedicular cortex, with no neurovascular contact,
- Grade 2: More than 25% of the screw penetrated the pedicular cortex,
- Grade 3: Grade 2 perforation with additional neurovascular contact, with more than 50% perforation.

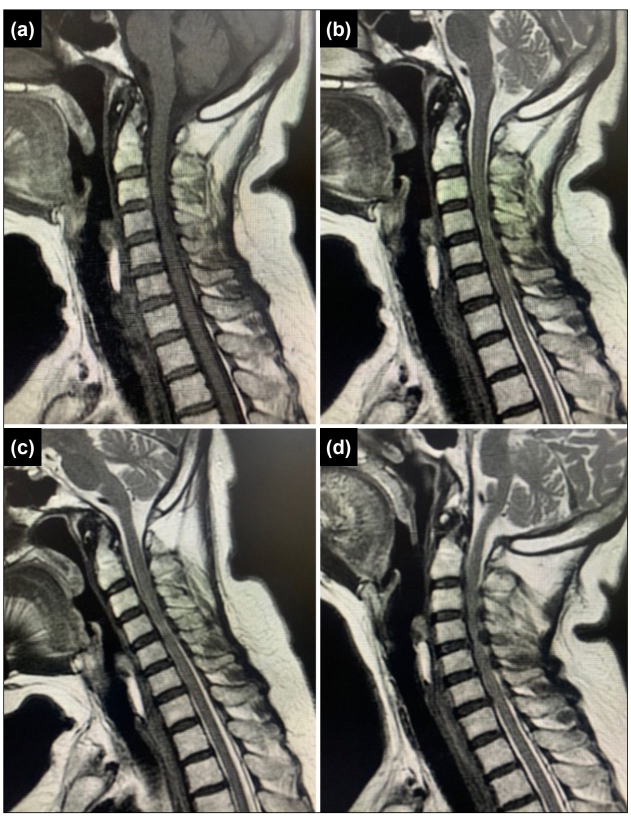

Figure 1. (a) Preoperative T1-weighted magnetic resonance imaging (MRI) in the neutral position. **(b)** Preoperative T2-weighted MRI in the neutral position. **(c)** Preoperative T2-weighted MRI in flexion. **(d)** Preoperative T2-weighted MRI in extension.

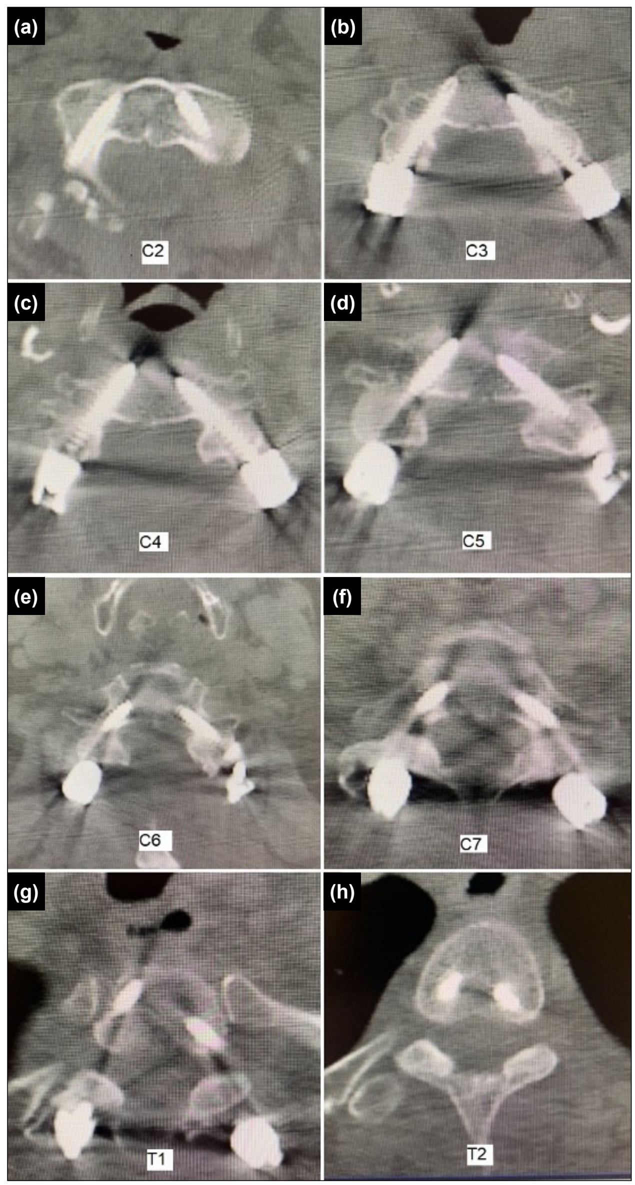

Figure 2. (a-h) Postoperative axial computed tomography (CT) images from C2 to T2.

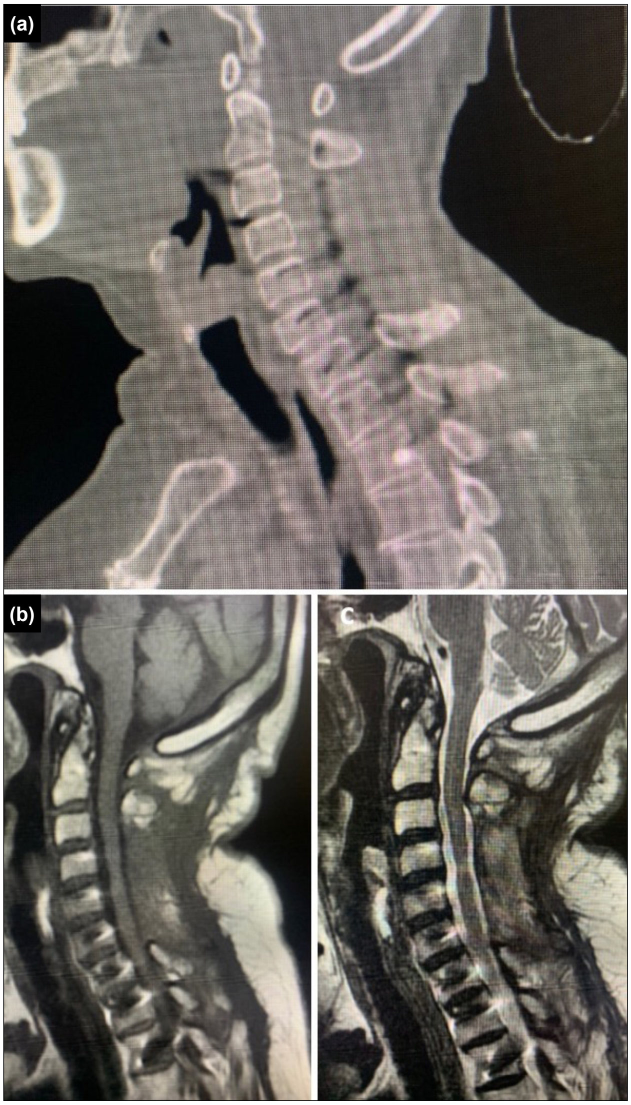

Figure 3. **(a)** Postoperative sagittal computed tomography (CT) images. **(b)** Postoperative six-month T1-weighted magnetic resonance imaging (MRI). **(c)** Postoperative six-month T2-weighted MRI.

Case 1: A 71-year-old female patient presented to the neurosurgery outpatient clinic with severe neck pain, numbness and pain in both arms, and complaints of imbalance. She had no motor neurological deficits. Her deep tendon reflexes were increased, and Hoffman reflexes were positive. Preoperative magnetic resonance imaging (MRI) showed C3-T1 spinal stenosis (Fig. 1). C2-T2 posterior stabilization and C3-C6 total laminectomy with decompression were performed. Postoperative images showed that all screws were classified as Grade 0 (Fig. 2). Postoperative MRI confirmed that adequate spinal canal decompression was achieved using this technique (Fig. 3).

Case 2: A 47-year-old male patient presented to the neurosurgery outpatient clinic with neck pain, numbness in both arms, and difficulty walking. He had no motor neurological deficits but exhibited bilateral lower extremity spastic paraparesis. His deep tendon reflexes were increased. Preoperative magnetic resonance imaging showed C3-C7 spinal stenosis (Fig. 4A-B). Using a surgical microscope, C3-T2 posterior stabilization and C3-C6 total laminectomy with decompression were performed. Postoperative images showed that all screws were classified as Grade 0 (Fig. 4C-5). Postoperative MRI also confirmed that adequate spinal canal decompression was achieved using this technique (Fig. 6).

Figure 4. **(a)** Preoperative T2-weighted magnetic resonance imaging (MRI) in the neutral position. **(b)** Preoperative T2-weighted MRI in extension. **(c)** Postoperative sagittal computed tomography (CT) image.

Statistical Analysis

The calculations presented in this study were performed using https://www.calculator.net/mean-median-mode-range-calculator.html and https://www.medcalc.org/calc/).

RESULTS

In this study, we retrospectively analyzed 70 cases. Fifty patients were male, and 20 were female. Patient ages ranged from 20 to 89 years (median: 64 years). Fifty-seven patients (81.5%) had cervical stenosis-related indications for surgery. Among the remaining patients, seven had fractures, four had sustained injuries in traffic accidents, and two had tumors. Trauma patients underwent surgery due to instability caused by fracture-dislocation and ligamentous injury, as identified on

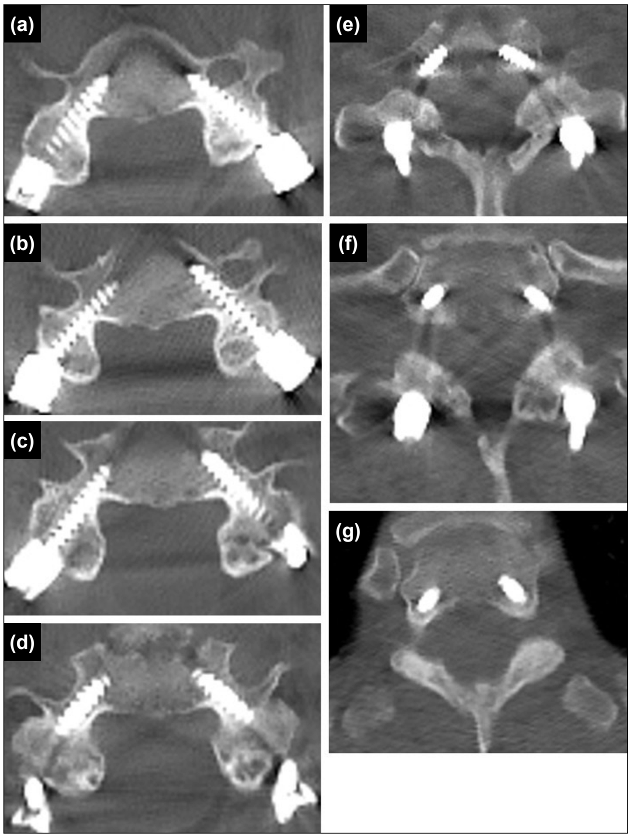

Figure 5. (a-g) Postoperative axial computed tomography (CT) images from C3 to T2.

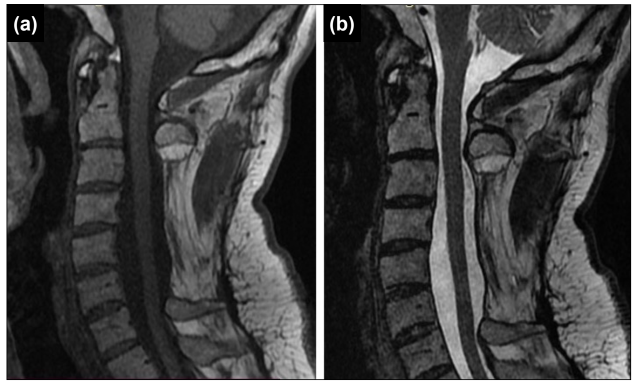

Figure 6. (a) Postoperative six-month T1-weighted magnetic resonance imaging (MRI). **(b)** Postoperative six-month T2-weighted MRI.

cervical MRI. In cases involving cervical spondylotic myelopathy and tumors, posterior cervical stabilization was planned to prevent iatrogenic instability and post-laminectomy kyphosis that could result from decompression at multiple consecutive levels.

A total of 468 pedicle screws were placed by the senior neurosurgeon (EC). Postoperative imaging was evaluated by three neurosurgeons, who graded the cervical pedicle screws. Of the screws placed, 434 were classified as Grade 0-1, corresponding to a correct placement rate of 92.7%. Thirty-four screws were malpositioned (Grade 2-3), representing a 7.3% malposition rate. However, revision surgery was not required, as no postoperative neurological deficits were observed. No intraoperative or postoperative vertebral artery injuries occurred in any of the patients in this series. In one of our cases, wound debridement was performed due to a wound site infection, while in three cases, cerebrospinal fluid fistulas were treated with external lumbar drainage. In four cases operated on for cervical spondylotic myelopathy, C5 palsy developed despite no malposition of the screws; however, all cases improved within the first postoperative month with physical therapy. The detailed characteristics of each patient and the screw grades are provided in Table 1.

Malposition was detected in 20 (7.43%) of the 269 pedicle screws placed in 41 cases operated on without a microscope, and in 14 (7.03%) of the 199 pedicle screws placed in 29 cases operated on under a microscope. There was no statistically significant difference between these approaches.

DISCUSSION

Cervical spondylotic myelopathy is a debilitating condition that may affect gait and lead to spastic quadriplegia. Decompression and accompanying stabilization are essential components of its surgical management.[1] Additionally, in cases of cervical trauma and tumors, stabilization may be required when instability is evident. In selected cases, minimally invasive endoscopic approaches may be preferred for cervical disc pathologies.[8-10] These smaller incisions offer advantages such as less tissue damage, shorter hospital stays, and faster recovery. In our series, cervical instability was significant, and posterior segmental stabilization was necessary.

We applied our technique in cases where instability was evident and in those requiring multilevel laminectomy. In cervical spondylotic myelopathy, cervical stability may be compromised after laminectomy or laminoplasty, potentially leading to kyphotic spinal deformities. In stable, multilevel cervical spondylotic myelopathy cases, it has been reported that the unilateral hemilaminectomy with bilateral osteoligamentous decompression technique does not result in postoperative cervical kyphosis or cervical instability. This approach also provides significant long-term improvements in Nurick grades, Visual Analog Scale (VAS) scores, and modified Japanese Orthopaedic Association (mJOA) scores. It has been suggested that this technique may eliminate the need for anterior and posterior fusion in certain cases of cervical spondylotic myelopathy.[11] Additionally, the bilateral decompression technique using cervical endoscopic unilateral laminoforaminotomy has been reported as a less invasive alternative to traditional decompression surgeries in cases of myelopathy caused by cervical stenosis.[12]

The pedicle is the strongest component of the vertebral body.[2] Pedicle screws provide significant holding capacity because they traverse all three columns. In 1994, Abumi et al.[13] described the technique and reported 13 cases of pedicle fixation for traumatic lesions of the lower cervical spine, marking the first report of pedicle screw insertion from C3 to C6. Abumi et al.[14-16] later extended the use of cervical screw fixation to non-traumatic injuries, cervical kyphosis correction, and craniocervical junction repair.

The conventional approach to cervical pedicle screw placement has a steep learning curve. Challenges include low accuracy, repeated punctures, different perspectives, and a high breach rate, all of which depend heavily on the surgeon's experience. Therefore, when using the freehand technique for cervical pedicle screw placement, surgeons must consider individual anatomical variations and develop a patient-specific surgical plan.[2]

Using a high-speed burr with a diamond tip, Abumi[1] described how to create a funnel-shaped hole at the screw insertion point, extending down to the pedicle entry. Compared to the posterior part of the lateral mass, the pedicle cavity entrance provides surgeons with a greater range of motion for adjusting the screw insertion angle. As a result, once a funnel-like hole has been created, the screw can be inserted at a less oblique angle than the pedicle's true anatomical axis.

We used the Celikoglu technique, as previously reported.[7] In these cases, we used a drill to create the entry hole and a probe to follow the trajectory. Additionally, we performed a mini-laminotomy to palpate the pedicle medially and determine the medial trajectory, thereby increasing the accuracy. In our previous case series using this technique, we reported an accuracy rate of 90.3% in 227 cervical pedicle screws. In the current case series, the accuracy was 92.7% for 468 cervical pedicle screws. This supports the safety and reliability of our technique.[6] Lee et al.[17] also reported 90% accuracy with their “Key Slot Technique.” Our outcomes are similarly successful, achieved without excessive radiation exposure and with favorable clinical results. The morphometric characteristics of the pedicles were carefully analyzed using preoperative computed tomography scans. During surgery, the superior and inferior borders of the pedicle were palpated using a hook through the mini-laminotomies, and screws were placed following the determined pedicle trajectory. In cases where decompression was performed, the medial surfaces of the pedicles were also examined for malposition. Therefore, fluoroscopy was used only once, after all screws had been placed.

The most reliable spinal fixation method to date is posterior pedicle screw fixation.[16] Biomechanical studies have shown that cervical pedicle screws offer greater strength during fatigue testing and a significantly lower rate of loosening at the bone-screw interface.[18,19] However, due to the small pedicle diameters, steep pedicle angles, and thin lateral cortex of the cervical vertebrae, cervical pedicle screw placement is technically demanding and associated with potential complications. The risk of injuring the vertebral artery or nerve root is a constant concern for surgeons, and minimizing those risks is critical for achieving favorable clinical outcomes. Medial malposition of a pedicle screw can endanger the spinal cord and root, while lateral perforation puts the vertebral artery at risk.[20] In our series, no intraoperative or postoperative vertebral artery injuries were observed. Although 34 pedicle screws were assessed as malpositioned, revision was not required, as none resulted in postoperative neurological deficits. This may be attributed to the 2-6 mm safe zone adjacent to the medial wall of the pedicle, as demonstrated in anatomical studies.[21]

CONCLUSION

In this study, we demonstrated that the freehand technique is a safe and feasible method for cervical pedicle screw insertion. The surgeon’s experience and thorough preoperative planning are essential when using the freehand technique for cervical pedicle screw placement.

Ethics Committee Approval: This study was approved by the Health Sciences Univeresity İstanbul Fatih Sultan Mehmet Training and Research Hospital Ethics Committee (Date: 25.03.2021, Decision No: FSMEAH-KAEK 2021/37).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: A.B., P.K.B., E.Ç.; Design: A.B., P.K.B., E.Ç.; Supervision: A.B., P.K.B., E.Ç.; Resource: A.B., P.K.B., E.Ç.; Materials: A.B., P.K.B., E.Ç.; Data collection and/or processing: A.B., P.K.B., E.Ç.; Analysis and/or interpretation: A.B., P.K.B., E.Ç; Literature review: P.K.B.; Writing: P.K.B.; Critical review: A.B., E.Ç.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

REFERENCES

1. Abumi K. Cervical spondylotic myelopathy: Posterior decompression and pedicle screw fixation. Eur Spine J 2015;24:186-96. [CrossRef]
2. Yu Z, Zhang G, Chen X, Chen X, Wu C, Lin Y, et al. Application of a novel 3D drill template for cervical pedicle screw tunnel design: A cadaveric study. Eur Spine J 2017;26:2348-56. [CrossRef]
3. Tomasino A, Parikh K, Koller H, Zink W, Tsiouris AJ, Steinberger J, et al. The vertebral artery and the cervical pedicle: Morphometric analysis of a critical neighborhood. J Neurosurg Spine 2010;13:52-60. [CrossRef]
4. Ito Y, Sugimoto Y, Tomioka M, Hasegawa Y, Nakago K, Yagata Y. Clinical accuracy of 3D fluoroscopy-assisted cervical pedicle screw insertion. J Neurosurg Spine 2008;9:450-3. [CrossRef]
5. Börekci A, Hiçdönmez T. Three-dimensional computed tomography measurements of pedicle diameters and angles for the safety of posterior cervical spinal instrumentation. South Clin Ist Euras 2024;35:243–8. [CrossRef]
6. Joaquim AF, Mudo ML, Tan LA, Riew KD. Posterior subaxial cervical spine screw fixation: A review of techniques. Glob Spine J 2018;8:751–60. [CrossRef]
7. Celikoglu E, Borekci A, Ramazanoglu AF, Cecen DA, Karakoc A, Bektasoglu PK. Posterior transpedicular screw fixation of subaxial vertebrae: Accuracy rates and safety of mini-laminotomy technique. Asian J Neurosurg 2019;14:58-62. [CrossRef]

8. Aydin Y, Kaya RA, Can SM, Türkmenoğlu O, Cavusoglu H, Ziyal IM. Minimally invasive anterior contralateral approach for the treatment of cervical disc herniation. Surg Neurol 2005;63:210-8. [CrossRef]
9. Liawrungrueang W, Cho ST, Sharma A, Cholamjiak W, Wu MH, Yau LC, et al. Clinical outcomes and patient perspectives in full endoscopic cervical surgery: A systematic review. Neurospine 2025;22:81-104. [CrossRef]
10. Aydin Y, Çavusoglu H, Yüce I, Özdilmaç A, Kahyaoglu O. A prospective study of interbody fat graft application with the anterior contralateral cervical microdiscectomy to preserve segmental mobility. Neurosurgery 2017;81:627-37. [CrossRef]
11. Ogden M, Karagedik MI, Ozdemir A, Bulut IU, Erdogan AM, Bakar B. Investigation of the efficacy of bilateral osteoligamentous decompression via hemilaminectomy in cervical spondylotic myelopathy: A clinical study. World Neurosurg 2023;180:e560–78. [CrossRef]
12. Chien KT, Chen YC, Chang TK, Liu YC, Chen LP, Huang YC, et al. Novel cervical endoscopic unilateral laminoforaminotomy for bilateral decompression in cervical spondylosis myeloradiculopathy: A technical note and clinical results. J Clin Med 2024;13:1910. [CrossRef]
13. Abumi K, Itoh H, Taneichi H, Kaneda K. Transpedicular screw fixation for traumatic lesions of the middle and lower cervical spine: Description of the techniques and preliminary report. J Spinal Disord 1994;7:19-28. [CrossRef]
14. Abumi K, Kaneda K. Pedicle screw fixation for nontraumatic lesions of the cervical spine. Spine 1997;22:1853-63. [CrossRef]
15. Abumi K, Shono Y, Taneichi H, Ito M, Kaneda K. Correction of cervical kyphosis using pedicle screw fixation systems. Spine 1999;24:2389-96. [CrossRef]
16. Abumi K, Takada T, Shono Y, Kaneda K, Fujiya M. Posterior occipitocervical reconstruction using cervical pedicle screws and plate-rod systems. Spine 1999;24:1425-34. [CrossRef]
17. Lee SH, Kim KT, Abumi K, Suk KS, Lee JH, Park KJ. Cervical pedicle screw placement using the "key slot technique": The feasibility and learning curve. Clin Spine Surg 2012;25:415–21. [CrossRef]
18. Johnston TL, Karaikovic EE, Lautenschlager EP, Marcu D. Cervical pedicle screws vs. lateral mass screws: Uniplanar fatigue analysis and residual pullout strengths. Spine J 2006;6:667-72. [CrossRef]
19. Ito Z, Higashino K, Kato S, Kim SS, Wong E, Yoshioka K, et al. Pedicle screws can be 4 times stronger than lateral mass screws for insertion in the midcervical spine: A biomechanical study on strength of fixation. J Spinal Disord Tech 2014;27:80-5. [CrossRef]
20. Abumi K, Shono Y, Ito M, Taneichi H, Kotani Y, Kaneda K. Complications of pedicle screw fixation in reconstructive surgery of the cervical spine. Spine 2000;25:962-9. [CrossRef]
21. Upendra B, Raghavendra R. Techniques of cervical pedicle screw insertion in lower cervical spine - A review. J Clin Orthop Trauma 2020;11:794-801. Erratum in: J Clin Orthop Trauma 2020;11:1176. Erratum in: J Clin Orthop Trauma 2021;21:101561. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Posterior subaksiyel servikal pedikül vidası ile ameliyat edilen servikal olguların sonuçları: Tek merkezli retrospektif bir çalışma

AMAÇ: Servikal pedikül vidasının diğer stabilizasyon sistemlerine göre biyomekanik avantajları vardır. Bununla birlikte, servikal pedikül vidası tekniği, bireysel farklılıklar ve servikal omurganın mimari özellikleri nedeniyle oldukça yüksek vasküler veya nörolojik hasar riski taşımaktadır. Bu nedenle, vidayı pedikül içine güvenli ve doğru bir şekilde yerleştirirken hastaya özgü anatomiyi anlamak çok önemlidir. Bu çalışmada, subaksiyel servikal pedikül vidası ile ameliyat edilen 7 yıllık tek merkezli olgu serimizi sunduk.
GEREÇ VE YÖNTEM: 2017-2024 yılları arasında servikal subaksiyel pedikül vidası ile ameliyat edilen hastaları retrospektif olarak analiz ettik. Cerrahi teknik şu şekildeydi: pedikül giriş noktası superior artiküler prosesin orta noktasının 1-2 mm lateralindeydi ve mini laminotomi tekniği cerrahın pedikülün medial gidişatını hissetmesini sağladı.
BULGULAR: Bu çalışmada 70 olgu retrospektif olarak analiz edildi. Hastaların 50'si erkek, 20'si kadındı. Hastalar 20-89 yaş arasındaydı (medyan 64 yaş). Elli yedi hastada (%81.5) servikal stenozla ilişkili ameliyat endikasyonu vardı. Diğer hastaların onbirinde kırık ve ikisinde tümör vardı. Yerleştirilen 468 pedikül vidasının 434'ü grade 0-1 idi. Doğru yerleştirme oranı %92 idi. Otuz dört vida malpoze olarak değerlendirildi (derece 2-3) ve oranı %8 idi.
SONUÇ: Olgu serimizde servikal subaksiyel pedikül vidası yerleştirme doğruluğu oldukça yüksekti ve bu doğruluğu elde etmek için iyi bir anatomik bilgi ve üç boyutlu düşünme becerisinin, cerrahi tecrübe ile desteklenmesi gerektiğini düşünmekteyiz.

Anahtar sözcükler: Servikal subaksiyel pedikül vidası; servikal spondilotik miyelopati; servikal travma; servikal tümör.

Ulus Travma Acil Cerrahi Derg 2025;31(8):798-803 DOI: 10.14744/tjtes.2025.83686