Journal of Medical Science and Sports Health

JoMaSSH, 2 (1), 2026, p. 46-53

available online at https://journal.uny.ac.id/publications/jomassh
doi: 10.21831/jomassh.v2i1.2835

Type of Paper: Case Report

Significant Neurological Recovery After Severe Cervical Spine Injury in Elite Wrestling Athlete: A Case Report

Diana Rela Oktaviani [1]*, Angelina Febrian Santoso [1], and Petra Octavian Perdana Wahjoepramono [2]

[1] Faculty of Medicine, Pelita Harapan University, Indonesia, Banten, Tangerang
[2] Department of Neurosurgery, Siloam Hospitals Lippo Village, Indonesia, Banten, Tangerang
* Correspondence: dianarelaoktaviani59@gmail.com

Article history:
Received: 20 March 2026
Revised: 25 April 2026
Accepted: 30 April 2026

How to Cite: Oktaviani, DR.; Santoso, AF.; Wahjoepramono, POP. (2026). Significant Neurological Recovery After Severe Cervical Spine Injury in Elite Wrestling Athlete: A Case Report. JoMaSSH, 2(1), 46-53. doi: 10.21831/jomassh.v2i1.2835

E-ISSN 3109-5666

Abstrak:

Pendahuluan: Trauma medula spinalis servikal traumatik dapat menyebabkan defisit motorik, sensorik, dan otonom yang berat yang berujung pada disabilitas jangka panjang. Gulat termasuk salah satu olahraga dengan risiko tinggi terjadinya cedera servikal akibat manuver dan rentang gerak yang ekstrem pada leher. Fraktur dan dislokasi servikal merupakan penyebab paling sering dari cedera medula spinalis, namun herniasi diskus servikal traumatik tanpa keterlibatan tulang juga dapat menyebabkan kompresi medula spinalis. Prosedur *anterior cervical discectomy and fusion* (ACDF) banyak digunakan untuk dekompresi dan stabilisasi trauma servikal, namun laporan untuk prosedur ACDF pada kasus herniasi diskus servikal multilevel akibat trauma masih terbatas. **Penyajian Kasus:** Seorang atlet gulat laki laki berusia 30 tahun, mengalami tetraplegia mendadak setelah melakukan salah satu manuver gulat. Pada pemeriksaan neurologis, didapatkan paralisis motorik lengkap pada keempat ekstremitas dengan defisit sensorik di bawah dermatom C4, sesuai dengan cedera medula spinalis klasifikasi Frankel derajat B. Pemeriksaan MRI menunjukkan herniasi diskus servikal multilevel pada tingkat C3–C4 dan C5–C6 yang menyebabkan kompresi medula spinalis signifikan tanpa disertai fraktur atau dislokasi vertebra. Prosedur ACDF segera dilakukan dalam waktu kurang lebih 60 jam setelah kejadian. Setelah operasi, fungsi neurologis pasien menunjukkan perbaikan yang progresif. Enam bulan pascaoperasi, pasien mencapai kemandirian fungsional dan dapat beraktivitas tanpa bantuan. **Kesimpulan:** Kasus ini menunjukkan bahwa tindakan ACDF multilevel dapat memberikan dekompresi dan stabilisasi medula spinalis yang efektif pada cedera medula spinalis servikal akibat herniasi diskus multilevel, menghasilkan pemulihan neurologis yang signifikan serta perbaikan fungsional pada atlet usia muda.

Kata kunci: *Cedera gulat; Cedera medulla spinalis servikal; Diskektomi servikal anterior dan fusi Herniasi diskus servikal traumatic; Trauma tulang belakang terkait olahraga*

Abstract:

Background: Traumatic cervical spinal cord injury (SCI) can result in severe motor, sensory, and autonomic deficits with significant long-term disability. Contact sports such as wrestling carry a heightened risk of cervical injuries due to high-impact maneuvers and extreme motion. Although cervical fractures and dislocations are common causes of SCI, traumatic cervical disc herniation without bony involvement can also lead to significant spinal cord compression. Anterior cervical discectomy and fusion (ACDF) is widely used to achieve spinal cord decompression and stabilization in cervical spine trauma. However, reports on its use in traumatic multilevel cervical disc herniation remain limited. **Case Presentation:** A 30-year-old male developed sudden tetraplegia after sustaining high impact cervical injury during a wrestling maneuver. Examination demonstrated complete motor paralysis of all extremities with sensory deficits below the C4 dermatome, consistent with Frankel grade B SCI. MRI shows multilevel cervical disc herniation at the C3–C4 and C5–C6 levels, causing significant spinal cord compression without associated vertebral fracture or dislocation. Approximately 60 hours after the incident, patient underwent urgent ACDF at both levels. Postoperatively, neurological function improved with recovery of motor strength, normalization of respiratory pattern, and gradual improvement of sensory deficits. Six months following surgery, patient regained functional independence and was able to ambulate and perform daily activities without assistance. **Conclusion:** This case highlights a successful multilevel ACDF, demonstrated by effective spinal cord decompression and stabilization in traumatic cervical SCI caused by multilevel disc herniation, leading to significant neurological recovery and favorable functional outcomes in a young athlete.

Keywords: *Anterior cervical discectomy and fusion; Cervical spinal cord injury; Sports-related spinal trauma; Traumatic cervical disc herniation; Wrestling injury*

1. Introduction

Contact sports such as wrestling carry a heightened risk of cervical injuries. In wrestling, athletes must support large weights on their head and neck and go through extreme range of motion in wrestling moves (1). Such burden on the neck could overwhelm the structural strength of the bones, intervertebral discs and ligaments, leading to deformation. Other than cervical fractures and dislocation, cervical disc herniation without bony involvement can also cause spinal cord injury (SCI).

Spinal cord injury is a severe neurological condition by mechanical compression or disruption of the spinal cord with substantial morbidity and mortality, often leading to significant motor, sensory, and autonomic deficits, and a major cause for long term disability (2). Wrestling moves have been proven to have the highest rate of catastrophic spinal cord injury, especially when performing takedown maneuvers (3,4).

Surgical management of patients with SCI aims to decompress the spinal cord, restore spinal alignment, and provide mechanical stability to prevent secondary neurological injury (2). Anterior cervical discectomy and fusion (ACDF) is one of the surgical techniques for decompression and stabilization in patients with cervical spine trauma with cervical disc herniation, giving a direct decompression and stabilization (5). Several clinical studies shows that early surgical decompression using anterior approaches is associated with improved neurological outcomes in patients with acute traumatic SCI (6).

However, published reports specifically describing the use of ACDF for traumatic multilevel cervical disc herniation remain limited. This case report is needed to describe the role of ACDF in the management of traumatic cervical spinal cord injury associated with multilevel disc pathology.

We present a case of spinal cord injury caused by multiple level cervical disc herniation treated with multiple level ACDF with exceptional neurological and functional outcomes.

2. Case Presentation

A 30-year-old male wrestling athlete, with BMI >25 Kg/m^2, experienced sudden onset of tetraplegia in a wrestling practice match. While defending against an over-the-shoulder SAMBO throw move (Brosok Cherez Plecho), the patient did not prepare adequately for contact with the sport mat and was thrown directly on his vertex with his entire body weight pressing down (**Figure 1**) (7,8).

Figure 1. Documentation of the mechanism of injury. The patient, dressed in blue, improperly defended against an over-the-shoulder throw and contacted the mat in a disadvantageous position.

At the time of injury the patient felt pain on his neck and reported a sensation of electric shock throughout his body, and was suddenly unable to move all his extremities. He remained conscious throughout the incident. After first aid at the arena, he was transported to a local clinic. It was then decided to transfer him to a regional hospital with CT scan availability, but no neurosurgeon on standby, where he was treated overnight to perform diagnostic tests. At this time, steroid administration was not performed at the regional hospital. Due to persistent tetraplegia and emerging respiratory discomfort, he was referred to our tertiary center, with full emergency neurosurgery capacity, approximately 32 hours after the injury.

On admission, he complained of shortness of breath and still unable to move all extremities. He had no significant previous medical history. On physical examination, the patient had a resting heart rate 68 beats per minute and blood pressure 125/78 mmHg. He displayed paradoxical breathing pattern, 22x/min. There were no outward signs of injury on his head and neck. Neurological examinations showed weakness in all four extremities, in both upper extremities (0000/0000) and lower extremities (0000/0000). Muscle tone was flaccid. Deep tendon reflexes and pathological reflex are absent in all extremities. Sensory examination shows hypoesthesia below C4 dermatome. There are no sensory or motor function preserved in sacral segments.

Magnetic resonance imaging (MRI) of the cervical spine shows multilevel cervical spondylosis with significant disc protrusions and spinal cord signal changes (**Figure 2**). At C3-C4 level there was a posteromedial disc protrusion causing spinal cord and nerve root compression. The spinal cord at the C3-C4 level showed T2 hyperintensity, indicative of spinal cord edema. At the C5-C6 level, there is a posterolateral disc protrusion dominantly to the right side, causing spinal cord and nerve root compression. The spinal cord does not show signal changes. These findings are consistent with multilevel cervical disc herniation with spinal cord compression, correlating with the patient's severe neurological deficits.

The patient was diagnosed with Frankel B Spinal Cord Injury below the level of C4, with multiple traumatic disc herniation and spinal cord compression. As more than 8 hours has passed since injury, high-dose corticosteroid was not administered.(9,10) Urgent surgical decompression with multilevel anterior cervical discectomy and fusion was performed the following morning.

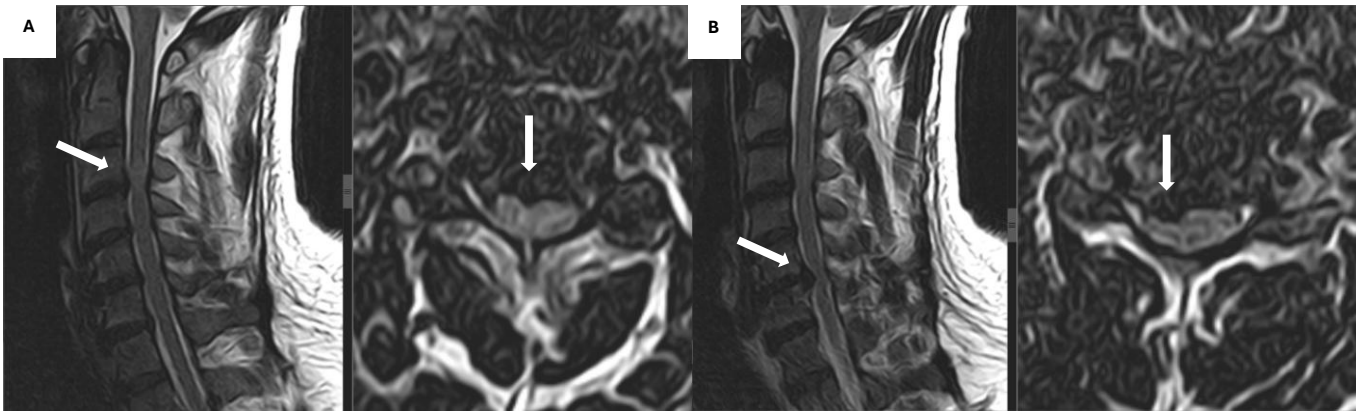

Figure 2. Pre-operative Non-contrast MRI imaging of the cervical spine. (A). T2-weighted image showing central cervical disc herniation without bony involvement at C3-C4 level, causing spinal cord signal changes (arrows). (B). T2-weighted image showing predominantly right sided cervical disc herniation without bony involvement at C5-C6 level, causing spinal cord signal changes (arrows).

Anterior Cervical Discectomy and Fusion (ACDF) was performed to decompress the spinal cord and stabilize the cervical spinal column at C3-4 and C5-6 levels. The annulus fibrosus of the intervertebral disc was opened, and all disc material was evacuated. All herniated fragments were meticulously removed. We confirm that the decompression is complete when we can see a good pulsation of the dura mater. After end plate preparation, sequentially larger trial cages were inserted into the intervertebral space to determine the optimal size of the implant. We used interbody polyetheretherketone (PEEK) cage implants, size 5 x 16 x 14 mm at both the C3-C4 and C5-C6 levels (**Figure 3**). The patient was immobilized postoperatively with a rigid cervical collar for 3 weeks.

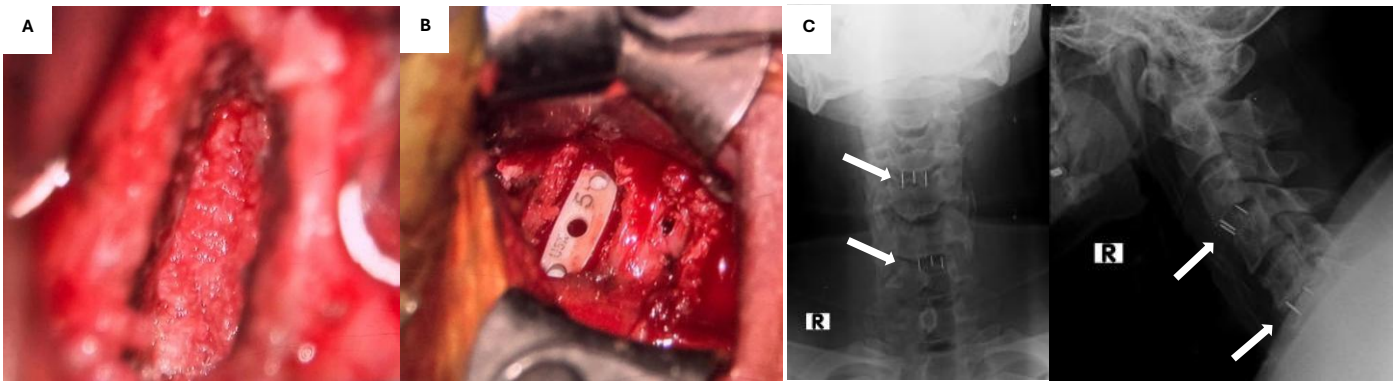

Figure 3. Intraoperative findings. (A). After evacuation of disc fragments at C3-4, the posterior longitudinal ligament has been adequately decompressed. (B). Disc replacement using a PEEK cage at the C3–C4 level. (C). Postoperative cervical spine x-ray showed cervical cage has been placed at the C3–C4 and C5–C6 intervertebral disc levels.

The patient recovered immediately postoperatively. His breathing pattern immediately normalized. Neurological examinations showed improvement in strength, with upper extremities (1133/3321) and lower extremities (3333/3333). Muscle tone returned to normal. Pathological reflexes are present in both extremities, especially the right-hand side. Sensory examination still shows hypoesthesia below C4 dermatome. Sensory and motor function of sacral segments returned.

One day after surgery, active and passive rehabilitation program was initiated. The rehabilitation program was continually modified according to the patient's recovering motoric strength. Ambulation was attempted at three days after surgery, and the patient was able to walk with assistance after one week. Rehabilitation program continued at the outpatient setting after the patient was discharged.

A follow-up MRI was obtained at one month post operation (**Figure 4**). Adequate decompression of the spinal canal with preserved alignment and well-positioned implant can be seen. At the C3-C4 level, there was mild residual posteromedial bulging disc, abutting the spinal cord but not causing compression. There was a CSF-signal lesion at the left dorsal column of spinal cord at the C3-C4 level, indicative of myelomalacia. At the C5-C6 level, there is a mild residual posterolateral bulging disc, but not causing compression. There were no spinal cord signal changes. These findings are consistent with ongoing neurological recovery.

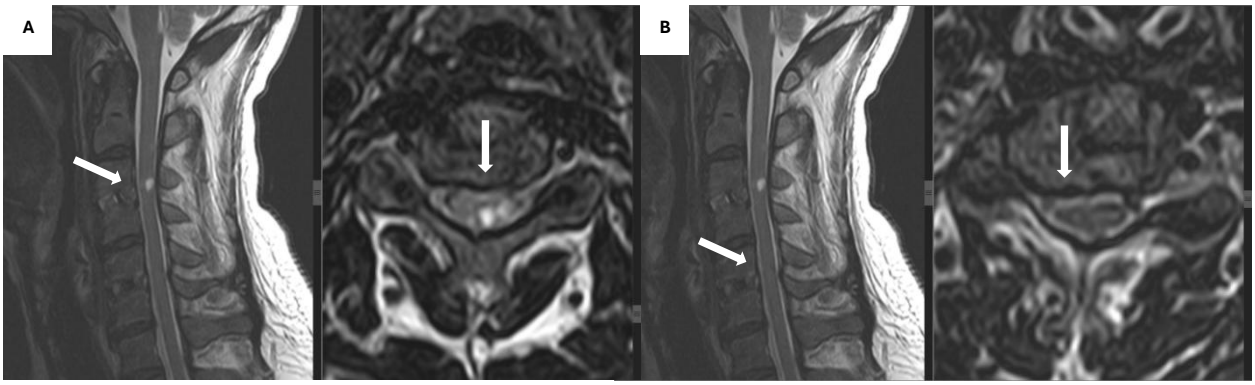

Figure 4. Postoperative follow-up: Non-contrast MRI of the cervical spine. (A). T2-weighted image of the C3-4 level showed cervical cage in good position with no compression of the spinal cord. There is myelopathy of the spinal cord (arrows). (B). T2-weighted image of the C5–6 level showed cervical cage in good position with no compression of the spinal cord. (arrows).

Six months after the operation, the patient has recovered enough to ambulate and perform daily activities by himself. There is residual weakness of his right-sided extremities, with motoric strength of the upper extremities (4455/5555) and lower extremities (5555/5555). The hypesthesia below the C4 dermatome has improved but still persists. Due to decreased motoric strength, the patient decided not to return to active duty as an athlete.

The patient stated that he had returned to normal daily activities and considered himself fully recovered. He had resumed gym training, including weightlifting, in 2024. He reported occasional residual abnormal sensations

in the fingers and right shoulder, previously the most severely affected area, but these did not interfere with his quality of life. The timeline of the events in this case is shown in **Figure 5**.

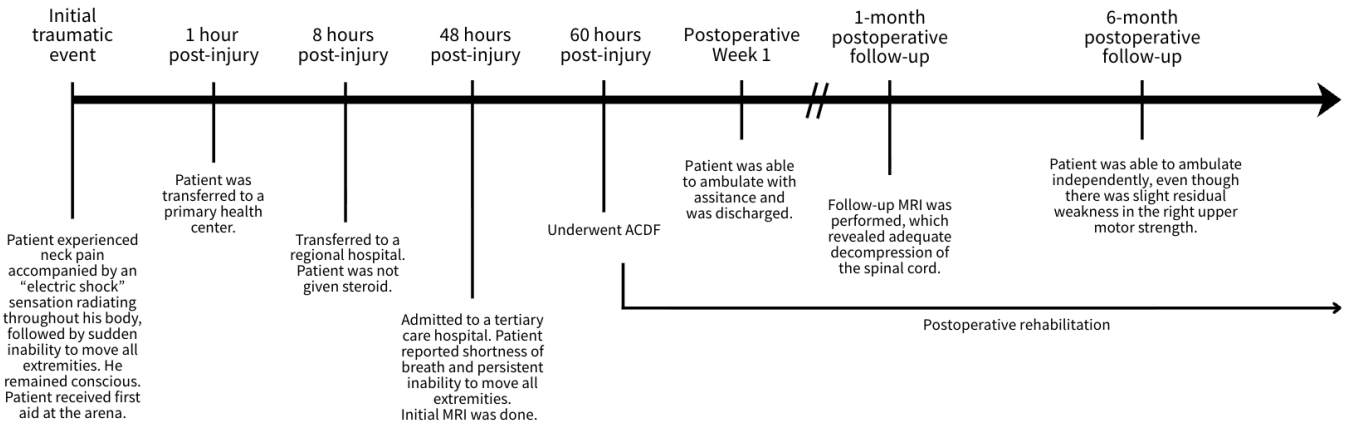

Figure 5. Timeline of events in the case study

The patient stated that he had returned to normal daily activities and considered himself fully recovered. He had resumed gym training, including weightlifting, since 2024 and was able to maintain a high level of physical function. He expressed gratitude for what he described as a "second chance," attributing his recovery not only to surgery but also to dedicated rehabilitation support. Although he occasionally experienced residual abnormal sensations in the fingers and right shoulder, these did not significantly affect his daily activities or overall quality of life.

3. Discussion and Conclusions

Various injuries are prone to happen in combat sports. This includes spinal injuries, such as cervical fractures, dislocations, strains, sprains, and disc herniations that can occur when athletes are exposed to high rotational or linear forces to the head and neck. Suspected neck injuries warrant immediate medical attention to prevent complications and improve outcomes (11,12). Traumatic SCI prevalence is roughly around 750 per million (6). In 2021, 7.42 million people globally were living with cervical spinal cord injury. The prevalence of neck-level spinal cord injury in Southeast Asia, East Asia, and Oceania was 1.8 million people in the same year (13).

Acute SCI involves both primary and secondary mechanisms, where the initial spinal cord compression and contusion trigger a downstream signaling cascade referred as secondary injury. Secondary injury can be prevented through neuroprotective measures and therapeutic interventions (6). Primary and secondary spinal cord injury is different from transient spinal cord injury, also known as Traumatic Neurapraxia, since the symptoms of neurapraxia generally resolve in less than 15 minutes, even though some have been reported to persist for up to 24 hours (14,15).

Therefore, surgical management plays an important role in the management of complex sports injuries, by preventing the development of secondary injury to the spinal cord. Cervical stabilizing techniques aimed to restore anatomical integrity, decompress injured neural components, reduction of fractures and fusion for long-term stability can be done through an anterior, posterior, or combined approach. However, the optimal choice and the timing of surgery are still debated (16,17).

Anterior surgical approach for traumatic cervical injury encompasses anterior cervical discectomy and fusion (ACDF) and corpectomy with fusion (ACCF), while the posterior approach consists of laminectomy or laminoplasty with or without fusion. The anterior approach is most commonly used, as it produces a desirable outcome, especially for cervical myelopathy caused by disc herniation and spondylosis. However, several complications have been reported following ACDF, such as inadequate decompression, recurrent myelopathy due

to adjacent segment degeneration, as well as graft-related problems such as displacement, fracture, and nonunion (18). Reduction can be achieved more easily with the posterior approach, and it provides a more stable fixation; therefore, it is usually indicated for multilevel cervical myelopathy (18,19). Acute blood loss, larger incision, and longer hospitalization were associated with the posterior technique (20). Patients also complained of postoperative neck pain caused by manipulation of the posterior muscles and ligaments (21).

ACDF was performed in our multilevel cervical spinal cord injury case, with excellent results at the 6-month follow-up. The decision to choose ACDF stems from several factors. The multilevel disc protrusion was causing ventral cord compression, making an anterior decompression anatomically suitable for the pathology. There was also no posterior ligament instability or facet dislocation needing posterior fixation. ACDF also allows minimal bleeding, faster recovery, and hospitalization (20). A retrospective cohort study from Chunpeng Ren et al. reported no significant difference in main Japanese Orthopaedic Association (JOA) scores, Neck Disability Index (NDI) scores, and American Spinal Injury Association grading (ASIA) scores between the anterior and posterior techniques for traumatic cervical dislocation with spinal cord injury. Nonetheless, the anterior approach is considered better at maintaining cervical lordosis, which equates to better long-term function (19). Neck muscles and ligaments are vital components in preserving cervical spine stability. ACDF can avoid disruption of those structures, thereby preserving the integrity of posterior structures needed for neck stability, strength, and resistance to high-impact forces (10). Posterior approaches are also associated with a higher incidence of postoperative axial neck pain (22). This is relevant in our case in particular, as our patient is a young athlete in whom preservation of posterior elements supports recovery and potential return to sport.

Adjacent segment disease (ASD) is a concern regarding the practice of ACDF. A meta-analysis of 21 studies from Qianmiau Zhu et al. reported the incidence of cervical ASD was 11%, with risk factors including pre-existing adjacent segment degeneration and postoperative decline in cervical lordotic curvature (23). Multilevel fusion tends to have a lower incidence of ASD, which might be attributed to the fusion of high-risk cervical levels C5-C7. Since ASD is unavoidable, it is imperative to address this problem pre-, intra-, and post-operatively. In our case, maintaining the physiological curvature of the cervical spine is important as abnormal biomechanics will eventually cause adjacent degeneration. Under- or oversizing of interbody and contoured plates is meticulously avoided to avoid overdistraction of the intervertebral segment (24).

Postoperative rehabilitation also contributed to the favorable functional outcome in patient. Multilevel ACDF gives spinal cord decompression and mechanical stabilization, but the long-term neurological recovery may also reflect the effect of structured rehabilitation. Postoperative physical therapy, including muscle strengthening, mobility training, and progressive return to activity programs, has been associated with improved pain control and functional outcomes (25). These findings are consistent with the clinical recovery observed in our patient.

Patient recovery in this case is notable, where Frankel grade B tetraparesis was able to improve to Frankel D, and the patient was able to function without an assistive device 6 months postoperatively. Residual neurological deficits are thought to be caused by myelopathy, visible by the presence of myelomalacia, characterized by intramedullary T2 signal change in the follow-up MRI.

In this case, favorable prognostic factors which include patient's young age, incomplete SCI, no comorbidities, immediate access to advanced imaging and specialized neurosurgical care in a tertiary center, combined with an uncomplicated postoperative course, offered a greater chance of neurological recovery and long-term survival outcome (26,27). When decompression was done in >24 hours, marked neurological improvement was still possible. Despite the patient's neurological deficit, it is possible for the patient to return to an elite level competition after rehabilitation, as the cervical spine is deemed structurally stable for the patient to return to play (4,28).

This paper demonstrates good clinical outcomes of ACDF in multilevel cervical SCI. However, findings in this case are based on a single patient and do not represent a wider population worldwide. Each patient's injury severity, timing of intervention, and comorbidities might produce variable results. Further follow-up from our case should

be done to evaluate possible chronic complications, long-term neurological recovery, cervical alignment, and fusion stability. Future research can compare anterior, posterior, or combined techniques to determine the optimal strategy for multilevel cervical SCI.

In summary, this case represents a traumatic multilevel cervical disc herniation with spinal cord injury in the absence of fracture or dislocation. Even with a normal cervical X-ray, we must have a high suspicion for spinal cord pathology, before ruling out SCIWORA (spinal cord injury without radiological abnormalities). Early MRI evaluation is recommended. Decompression of definite spinal cord pathology should always be attempted, even if the golden hour has been passed. Significant and life-changing neurological recovery is possible, even after >48 hours of trauma.

Acknowledgments: The authors would like to thank all medical staff of the Department of Neurosurgery Siloam Hospitals Lippo Village and to the patient and his family for their cooperation and consent in the publication of this case.

Author Contributions: Conceptualization and supervision, P.O.P.W.; investigation, data curation, and visualization, D.R.O. and A.F.S.; writing—original draft preparation, D.R.O.; writing—review and editing, D.R.O., A.F.S., and P.O.P.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

Informed Consent Statement: Informed consent was obtained from the patient involved in this study.

List of Abbreviations

ACDF	Anterior cervical discectomy and fusion
SCI	Spinal cord injury
MRI	Magnetic resonance imaging
PEEK	Polyetheretherketone

References

1. Lee K, Onate J, McCann S, Hunt T, Turner W, Merrick M, et al. The Effectiveness of Cervical Strengthening in Decreasing Neck-Injury Risk in Wrestling. J Sport Rehabil. 2017 Jul 1;26(4):306–10. https://doi.org/10.1123/jsr.2015-0101.
2. Fehlings MG, Tetreault LA, Wilson JR, Aarabi B, Anderson P, Arnold PM, et al. A Clinical Practice Guideline for the Management of Patients With Acute Spinal Cord Injury and Central Cord Syndrome: Recommendations on the Timing (≤24 Hours Versus >24 Hours) of Decompressive Surgery. Global Spine J. 2017 Sep 1;7(3 Suppl):195S-202S. https://doi.org/10.1177/2192568217706367 .
3. Boden BP, Lin W, Young M, Mueller FO. Catastrophic injuries in wrestlers. Am J Sports Med. 2002 Dec 1;30(6):791–5. https://doi.org/10.1177/03635465020300060601.
4. Hope JMV, Sane JC, Diao S, Sy MH. Spinal Cord Injury Due to Cervical Disc Herniation without Bony Involvement Caused by Wrestling - A Case Report. J Orthop Case Rep. 2019;9(1):19–22. https://doi.org/10.13107/jocr.2250-0685.1290.
5. Wilson JR, Fehlings MG. Emerging Approaches to the Surgical Management of Acute Traumatic Spinal Cord Injury. Neurotherapeutics. 2011 Apr 1;8(2):187–94. https://doi.org/10.1007/S13311-011-0027-3.
6. Fehlings MG, Vaccaro A, Wilson JR, Singh A, Cadotte DW, Harrop JS, et al. Early versus Delayed Decompression for Traumatic Cervical Spinal Cord Injury: Results of the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS) [Internet]. https://doi.org/10.1371/journal.pone.0032037
7. Gulevich DI, Zvyagintsev GN. Bor'ba sambo [Sambo wrestling]. Moscow: Voenizdat; 1968.
8. Markotenko NN. Sambo: Priyemy samozashchity bez oruzhiya [Sambo: Techniques of self-defense without weapons]. Moscow: MVD; 1947.
9. Fehlings MG, Wilson JR, Tetreault LA, Aarabi B, Anderson P, Arnold PM, et al. A Clinical Practice Guideline for the Management of Patients With Acute Spinal Cord Injury: Recommendations on the Use of Methylprednisolone Sodium Succinate. Global Spine J. 2017 Sep 1;7(3 Suppl):203S-211S. https://doi.org/10.1177/2192568217703085.
10. Kuo C, Sheffels J, Fanton M, Yu IB, Hamalainen R, Camarillo D. Passive cervical spine ligaments provide stability during head impacts. J R Soc Interface. 2019 May 1;16(154). https://doi.org/10.1098/RSIF.2019.0086.
11. Bakirtzis D, Gkiafi Z, Sioutis S, Tolis IP, Zikopoulos A, Lykoudis PM, et al. A Narrative Review of Combat Sports Injuries With a Particular Focus on Cervical Spine Injuries. Cureus. 2024 Dec 2;16(12):e74980. https://doi.org/10.7759/cureus.74980.
12. Brown DA, Leung FT, Evans K, Grant G, Hides JA. Cervical spine characteristics differ in competitive combat athletes compared with active control participants. Musculoskelet Sci Pract. 2022 Oct 1;61:102614. https://doi.org/10.1016/j.msksp.2022.102614.
13. Kim M, Jeong W, Jang S, Park JH, Bae Y, Lee SW. Spinal Cord Injury Epidemiology and Causes: A Worldwide Analysis with 2050 Projections. Healthcare (Switzerland). 2025 Oct 1;13(20):2552. https://doi.org/10.3390/healthcare13202552

14. Joaquim AF, Hsu WK, Patel AA, Joaquim AF, Hsu WK, Patel AA. Cervical spine surgery in professional athletes: a systematic review. Neurosurg Focus. 2016 Apr 1;40(4):E10. https://doi.org/10.3171/2016.1.FOCUS15560.
15. Clark AJ, Auguste KI, Sun PP, Clark AJ, Auguste KI, Sun PP. Cervical spinal stenosis and sports-related cervical cord neurapraxia. Neurosurg Focus. 2011 Nov 1;31(5):E7. https://doi.org/10.3171/2011.7.FOCUS11173.
16. Ropper AE, Neal MT, Theodore N. Acute management of traumatic cervical spinal cord injury. Pract Neurol. 2015 Aug 1;15(4):266–72. https://doi.org/10.1136/practneurol-2015-001094.
17. Singh A, El-Hajj VG, Fletcher-Sandersjöö A, Aziz N, Ghaith AK, Tatter C, et al. Predictors of failure after primary anterior cervical discectomy and fusion for subaxial traumatic spine injuries. European Spine Journal 2024 33:6. 2024 Apr 25;33(6):2332–9. https://doi.org/10.1007/s00586-024-08264-z .
18. Xu L, Sun H, Li Z, Liu X, Xu G. Anterior cervical discectomy and fusion versus posterior laminoplasty for multilevel cervical myelopathy: A meta-analysis. International Journal of Surgery. 2017 Dec 1;48(1):247–53. https://doi.org/10.1016/j.ijsu.2017.06.030
19. Ren C, Qin R, Wang P, Wang P. Comparison of anterior and posterior approaches for treatment of traumatic cervical dislocation combined with spinal cord injury: Minimum 10-year follow-up. Sci Rep. 2020 Dec 1;10(1):10346. https://doi.org/10.1038/s41598-020-67265-2
20. Zhang Y, Yang G, Zhou T, Chen Y, Gao Z, Zhou W, et al. Efficacy and safety of anterior cervical discectomy and fusion (ACDF) through mini-incision and posterior laminoplasty (LAMP) for treatment of long-level cervical spondylosis: a retrospective cohort study. BMC Surg. 2022 Mar 25;22(1):115. https://doi.org/10.1186/s12893-022-01567-2
21. Hosono N, Yonenobu K, Ono K. Neck and shoulder pain after laminoplasty. A noticeable complication. Spine (Phila Pa 1976). 1996 Sep 1;21(17):1969–73. https://doi.org/10.1097/00007632-199609010-00005.
22. Zhang K, Xiong Z, Zhang Y, Zhuang Z, Zhan S, Tan M, et al. Risk factors of axial symptoms after posterior cervical spine surgery: a meta-analysis. BMC Surgery 2025 25:1. 2025 Aug 21;25(1):380-. https://doi.org/10.1186/S12893-025-03074-6
23. Zhu Q, Li N, Ding Y, Zhang Z, Jiang W, Jiang T, et al. Incidence of Adjacent Segment Degeneration and Its Associated Risk Factors Following Anterior Cervical Discectomy and Fusion: A Meta-Analysis. World Neurosurg. 2024 Mar 1;183:e153–72. https://doi.org/10.1016/j.wneu.2023.12.050
24. McCarthy MH, Weiner JA, Patel AA. Strategies to Achieve Spinal Fusion in Multilevel Anterior Cervical Spine Surgery: An Overview. HSS J. 2020 Jul 1;16(2):155–61. https://doi.org/10.1007/s11420-019-09738-3
25. Yang S, Yi YG, Kim Y, Jang DS, Chang MC. Postoperative Rehabilitation for Pain and Functional Recovery Following Anterior Cervical Discectomy and Fusion: A Narrative Review. J Pain Res. 2025;18:4173. https://doi.org/10.2147/JPR.S533252
26. Kang X, Zhang X bo, Gao X dan, Gao Z lin, Xu Z wei, Zhang Y. Prognostic influences and prediction model construction for traumatic cervical spinal cord injury. Front Neurol. 2026 Jan 9;16:1684409. https://doi.org/10.3389/fneur.2025.1684409
27. Singh R, Kumar RR, Setia N, Magu S. A prospective study of neurological outcome in relation to findings of imaging modalities in acute spinal cord injury. Asian J Neurosurg. 2015 Sep;10(3):181. https://doi.org/10.4103/1793-5482.161166
28. Jo J, Davidar AD, Hersh AM, Theodore N, Zuckerman SL. Cervical and Lumbar Disk Replacement in Athletes: Is It Safe to Return to Play? A Systematic Review of the Scientific Literature and Lay Press. Neurosurgery. 2024 Jan 1;94(1):4–13. https://doi.org/10.1227/neu.0000000000002637