Scalpellum
JOURNAL OF SURGERY & CLINICAL RESEARCH

Case Report

Thoracolumbar Fascia Grafting for Total Rupture of Dura Mater in Traumatic Spinal Cord Injury: Case Report

Syafruddin Husin[1], Eko Setiawan[2], Humaira Luqyana[3*], Muhammad Wiranata[3] and Fadhillah Arif[3]

[1]Department of Orthopaedics, Universitas Padjadjaran, Hasan Sadikin Hospital, Bandung, Indonesia
[2]Department of Orthopaedics, Universitas Indonesia, Jakarta, Indonesia
[3]Department of Surgery, Universitas Riau, Arifin Achmad Hospital, Pekanbaru, Indonesia

*Corresponding author: luqyanahumaira@gmail.com

Abstract

The impairment of the spinal cord could induce a prolonged neurological deficit, which is caused by traumatic Spinal Cord Injury (tSCI). This condition should be immediately treated. Repairment by using the fascia component would be better for improving spinal cord metabolism. A 28-year-old male working as an oil gardener was admitted to the emergency unit with a main complaint of pain around his back after having penetration trauma by a sickle tool two hours before admission. Swelling near the affected area and tenderness while performing palpation. The halo sign was found positive, AP-Lateral X-ray of thoracic vertebrae shows intact trabecula. The patient diagnosed by tSCI with dural tear and duraplasty was performed using thoracolumbar fascia grafting. Duraplasty procedure by using fascia grafting is preferred for managing tSCI, especially for patients with incised wound. Fascia grafting that was planted on the injured site could induce cord metabolism and spinal outflow. Intra-spinal pressure cannot be decreased solely by bone decompression; injured lesions often produce oedema, which compresses the spinal canal. Duraplasty is necessary to improve the patient's Quality of Life (QoL). Adequate modalities by using fascia grafting procedure would be easier to achieve the best possible outcome

Keywords: Case Report, Duraplasty, Fascia grafting, Spinal Cord Injury, Incised Wound

OPEN ACCESS
Submitted: 12 July 2025
Revised: 16 August 2025
Accepted: 22 October 2025
Published: 24 December 2025

Corresponding author
Humaira Luqyana
luqyanahumaira@gmail.com

Academic editor
Benni Iskandar

Data Availability Statement
All relevant data are within the paper and its Supporting Information files.

Introduction

Spinal Cord Injury (SCI) often happens in terms of traumatic or non-traumatic. Traumatic spinal cord injury is an acute trauma that occurs in the spinal canal and disrupts spinal components, metabolism, and leading to neurologic impairment.[1] According to the World Health Organization (WHO), almost 80% of cases happened because of traumatic incidents. Productive age population especially men often suffer from SCI due to heavier physical activities.[2]

An SCI is categorized into four types: anterior, central, conus-medullaris and posterior cord syndrome. Anterior cord mostly causing sensory loss of pain and temperature sensation. Syndrome of the central cord is usually seen with a motoric impairment predominantly in the upper extremities rather than lower limbs. Brown-Sequard syndrome clinical signs revealed an ipsilateral decreased of sensory function and motor weakness on the other side. Posterior cord syndrome comes with decreased sensation of vibration and touch.[3] Penetrating trauma could proceed to dural tears and induce inflammation. Prolonged compression will increase spinal pressure and reduce

spinal outflow.[3] In this case, early decompression and stabilization modalities may be considered with posterior approach.[4]

In our report, we will describe a tSCI caused by a penetrating trauma with thoracolumbar fascia grafting procedure. Dural tears occur in approximately 2–18% of spinal cord injury cases, and certain patients may require complex techniques such as grafting for optimal management. In a study conducted by Sang-Hun Lee *et al*, grafting procedures using fascia, muscle, or fat were performed in 15 patients. Among them, fascia grafting was performed in 6 patients, none of whom required reoperation.[5] The use of thoracolumbar fascia in fascia grafting procedures represents an optimal option for dural tear repair, offering several advantages such as providing a physical scaffold for re-epithelialization. The fascia functions as a biological conduit, bridging the gap between damaged segments of the spinal cord while promoting soft tissue healing and axonal regeneration. Utilizing autologous fascia minimizes the risk of immune rejection, thereby improving safety. There are also other treatment options, such as stem cell implantation or growth factor injection, that may be considered. Furthermore, the thoracolumbar fascia is relatively easy to harvest intraoperatively, as it is located in close proximity to the injured site, allowing for time efficiency and eliminating the need for additional incisions.[6] This case report has been reported in line with the SCARE 2025 checklist.[5]

Case

A 28-year-old male as taken by an ambulance to the emergency department with chief complaints of persistent pain with and tenderness around his back after being hit by a sickle tool. The patient working as an oil palm gardener was stabbed by sickle tool, serohemorrhagic fluid were drowned from the injured site. The patient advised by his friends to take a rest, but the patient could not hold it any longer due to persistent pain. The patient then transferred to emergency unit of primary health care, the patient arrived in stable condition with Visual analogue scale (VAS) score of 5. The general practitioner (GP) looking for the injured site on the back of his body, ongoing bleeding revealed during examination. A dressing using gauze was used to stop the bleeding and certain drugs either tranexamic acid and K vitamin administered. The GP plans to refer the patient using ambulance to emergency department of Arifin Achmad general hospital. During preparation, the patient was advised to fast and Intravenous access was installed with Ringer Lactate 1 gram. A wide spectrum antibiotic known as ceftriaxone 1 gram IV administered to prevent infection during 2 hours transport. After arrived on emergency department of Arifin Achmad general hospital we implement primary survey of the initial assessment showed no life-threatening condition with Glasgow Coma Scale (GCS) 15. The secondary survey shows no medical and surgical history and past illness. He stopped smoking and alcohol consumption since 10 years before admission. Hemodynamic within normal limit. Physical examination showed an open wound on the level of thoracolumbar segment T12-L1. Pain and swelling were found while palpating the injured site; the muscle function grading in both lower limbs was 0000/000. Neurological status was assessed according to the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI/ASIA) **[Table.1]** On admission the patient had lower limb motor score 0/50 with preserved sacral sensation (AIS B). At 2 months post-op there was emerging voluntary contraction in key lower limb muscles (MRC 1–2), with estimated lower limb motor score ≈16/50 compatible with AIS C. At 4 months the patient demonstrated antigravity strength (MRC 3) in the key lower limb muscles, yielding a lower limb motor score 30/50 and conversion to AIS D, with near-normal sensory recovery.

Table 1. ASIA Impairment Scale

Parameter	On admission (Day 0)	2 months post-op	4 months post-op
Motor (Upper limbs, total 50)	50/50	50/50	50/50
Motor (Lower limbs, total 50)	0/50 (R 0 + L 0)	**16/50** R: 8 (hip 2, knee 2, ankle DF 1, toe 1, PF 2) L: 8 (similar distribution)	**30/50** R: 15 (all 5 key muscles = 3) L: 15 (all 5 key muscles = 3)
Total motor score (max 100)	50/100	66/100	80/100
Light touch / Pinprick (sensory)	Absent below T12 (noted R > L)	Improved: hypesthesia below lesion (right worse)	Near-normal sensation below lesion (bilateral)
Sacral sparing (S4–S5)	Present (perianal sensation +, anal wink +, BCR +)	Present	Present
ASIA Impairment Scale (AIS) grade	**B** (sensory incomplete)	**C** (motor incomplete — motor function present below level; >50% key muscles <3)	**D** (motor incomplete — ≥50% key muscles below level have ≥3/5)

Anaesthesia was found in the right inguinal without abnormalities seen in bladder-bowel function [Figure.1]. Halo test was positive and blood test result within normal limit.

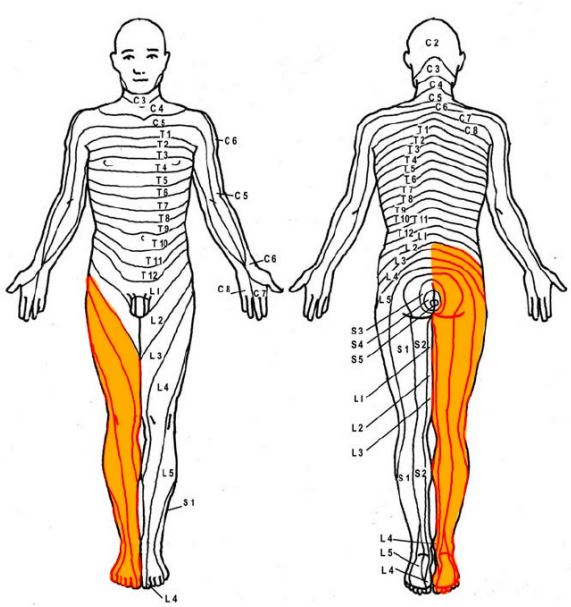
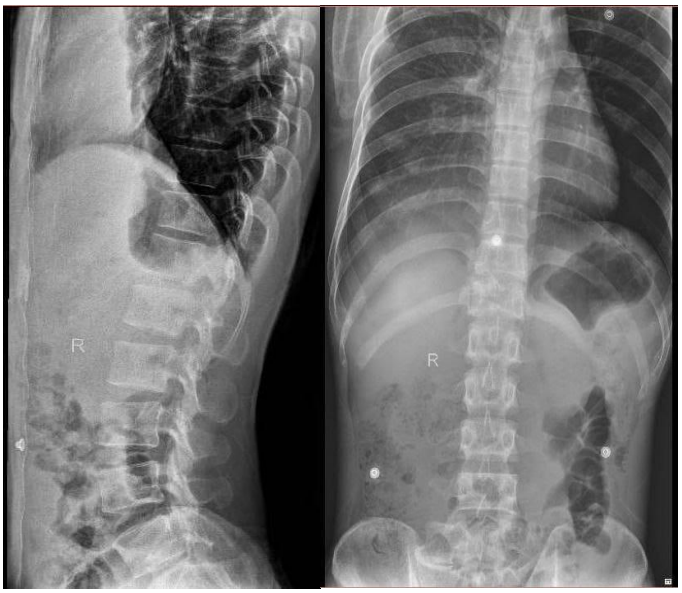


Figure 2. Cruris X-ray AP view (A), Lateral view of right cruris X-ray (B)

AP-Lateral X-ray of thoracic vertebrae shows intact trabecula, without osteophyte, listhesis, or sclerotic subchondral [Figure.2]. Early management of tSCI is needed to achieve the best possible prognostic.

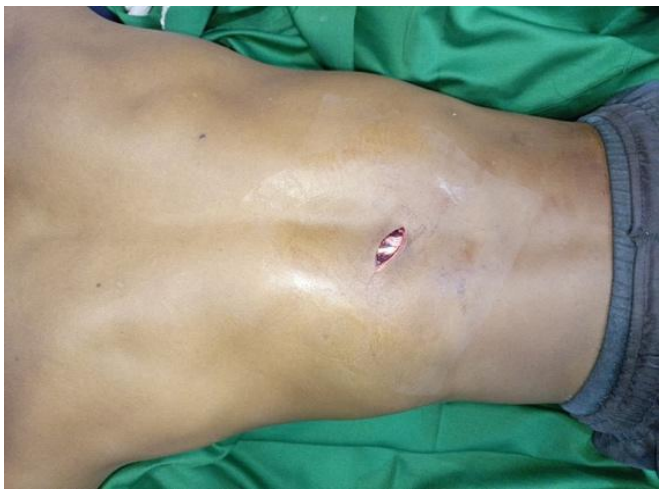


(A) (B)

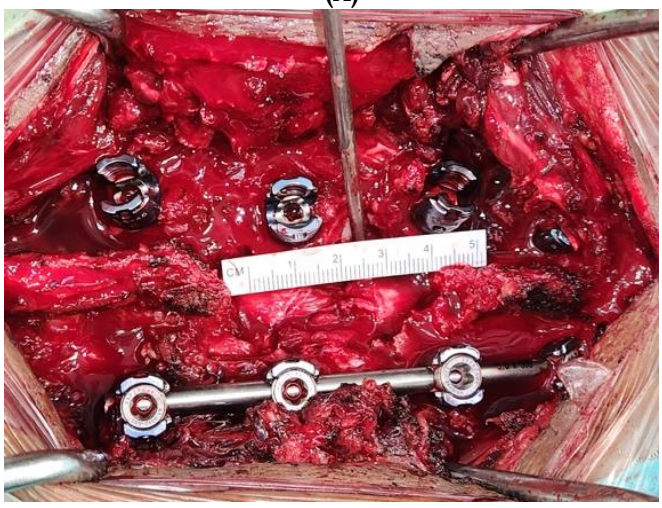
Figure 2. Lateral X-ray view of thoracolumbar segment (A), AP view of X-ray examination (B).

During pre-surgery preparation, the patient was administered with few intravenous drugs such as: Ketorolac 30mg/IV, Ceftriaxone 1g/IV, Omeprazole 40mg/IV, Tranexamic acid 1g/IV. Stabilization through a posterior approach with laminectomy and repair of the spinal canal by thoracolumbar fascia grafting procedure was performed. The reason why thoracolumbar fascia grafting was chosen in this case because the location is near the injured site. The thoracolumbar fascia does not directly trigger spinal metabolism but aids in the repair of soft tissues, preventing injuries from worsening by stabilizing the area, safeguarding nerves, and improving the repair of immune cells and nerves if those cells are present in the fascia.

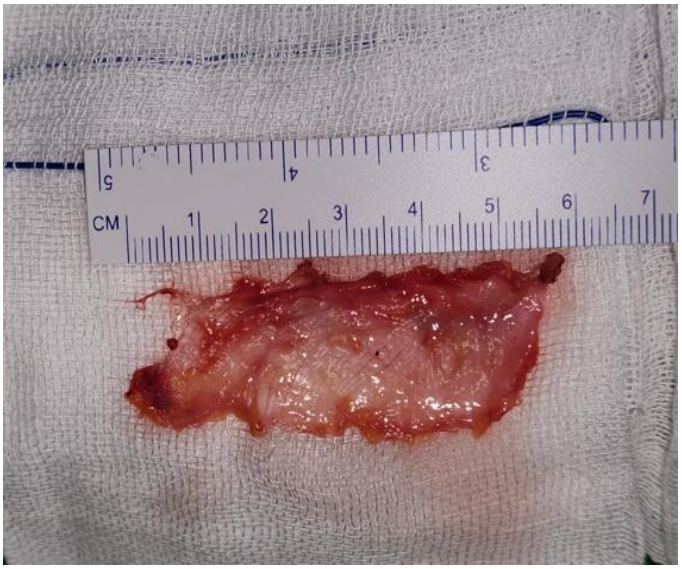
The primary role of fascia is to offer protection, aiding in the healing of the spine. This method aids the metabolism of the injured region indirectly, but it does not directly affect the functionality of the spinal cord. It could induce spinal metabolism and prevent prolonged soft tissue injury. here was no changed of planned intervention, and this surgery was conducted by an orthopedic surgeon at Arifin Achmad Hospital Pekanbaru. The patient had already given informed consent about publishing surgical reports, including pictures [Figure.3].



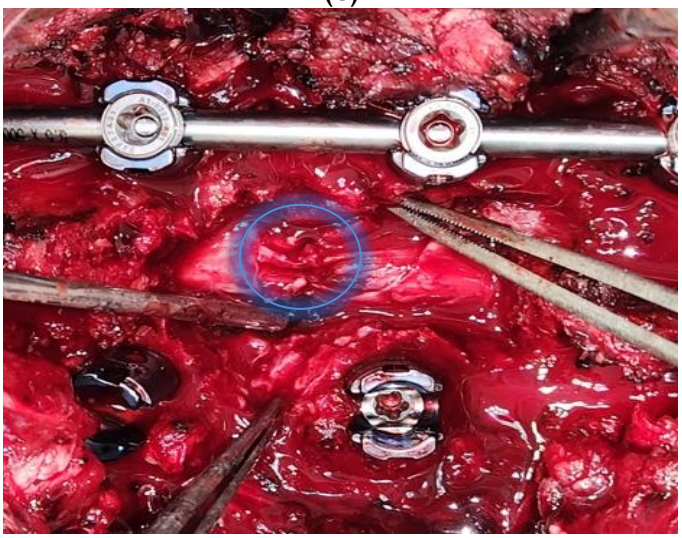
(A)



(B)



(C)



(D)

Figure 3. Clinical presentation of patient's pre-Operation (A) intra-Operation shows 2,4 cm dural tear (B), sample of thoracolumbar fascia (C), Dural tear in the thoracolumbar segment (D)

During surgery, the patient was performing a prone position under total intravenous anaesthesia (TIVA) and analgesics; wide-spectrum antibiotics were used intraoperatively. After being exposed, almost 80% of the dural defect was seen in the 12th thoracic lamina spinal was repaired, and the dural defect was closed using a graft from the thoracic fascia. Based on the Claven-Dindo classification, our patient is described as grade two (II). PRC for transfusion and IV drugs were used to stabilise the patient's haemodynamics.[6]

According to the surgical reports, the surgery lasted approximately 2-3 hours. After the surgical procedure was performed, the patient's hemodynamic was under observation in the surgical Intensive Care Unit (ICU) to prevent a variety of complications and neurogenic shock after the intervention. A thoracolumbar X-Ray with lateral projection was performed **[Figure.4].**

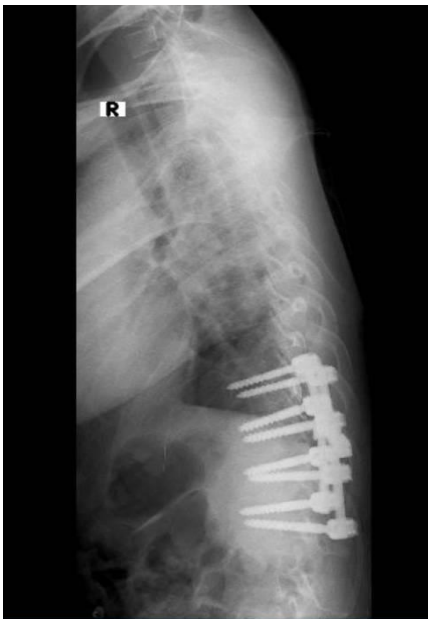


Figure 4. Lateral X-ray of the patient post decompression of the spinal cord.

In this patient, direct measurement of ISP and spinal cord perfusion pressure (SCPP) was not available due to limited monitoring facilities. Postoperative imaging with MRI was not performed, as there were no clinical signs suggestive of cerebrospinal fluid (CSF) leakage or pseudomeningocele, and the surgical wound remained dry and intact. After having intensive management in the ICU for 4 days. the patient was moved to an inpatient room to observe the vital signs and condition post-intervention. A week after surgery, the patient was consulted to rehabilitation medicine to improve the sensory and motor function with a variety of manoeuvres given by the physicians. Functional neurological recovery was objectively assessed using the ISNCSCI / AIS at baseline, two months, and four months after surgery for checking any improvement after rehabilitation. At 2 months postoperatively, voluntary contractions with Medical Research Council (MRC) grades 1–2 were present in several key lower limb muscles, increasing the lower limb motor score to 16/50 and reclassifying the injury as AIS Grade C. At 4 months, all key lower limb muscles achieved antigravity strength (MRC 3), yielding a lower limb motor score of 30/50 and further improvement to AIS Grade D. Sensory examination showed gradual recovery from absent sensation below T12 at presentation, to hypesthesia at 2 months, and near-normal sensation at 4 months. Upper limb motor scores remained full (50/50) throughout follow-up.

Discussion

The mechanism can result in tSCI, which has a severe effect on the patient's QoL. Early diagnosis decreases the risk of spinal cord inflammation in the lesion site and also increases the perfusion pressure. Besides of traumatic caused by incision, there might be several symptoms that will happen, such as a decrease in the function of the bladder and bowel system.[4,7] Spinal cord compression is more frequent in tSCI. The secondary injury, which happens after initial trauma, will activate the inflammatory cells, and axonal disrupted also followed by apoptosis of the glial cells. In the acute phase, early diagnosis can reduce morbidity and mortality.[7,8]

Decompression and stabilization through a posterior approach with laminectomy, stabilization of the spinal cord, dural repair, and thoracolumbar fascia grafting procedures were performed in this patient. There are many techniques to improve spinal outflow, such as laminectomy and laminoplasty.[4] Laminectomy is divided into direct and indirect modalities; visualized laminectomy was seen during the operation, while indirect begins with no visualization. Laminectomy associated with fusion is more frequently used by the surgeon, the goal is to improve spinal perfusion as soon as possible.[9]

Intraoperatively, we identified a large posterior dural defect (~2.4 cm) at the T12–L1 level with insufficient native dural edges for primary suture repair. Several closure techniques are described in the literature, including primary suture, autologous grafts (fascia lata, thoracolumbar fascia, fat, muscle), pedicled muscle flaps, synthetic dural substitutes, and adjunctive fibrin sealants.[10-12] Primary closure is ideal for small, approximable defects, but for larger gaps, an autologous graft provides a durable patch to minimize postoperative CSF leakage.[10] Thoracolumbar fascia was selected in this case because it was immediately accessible at the surgical site, had sufficient size and tensile strength for closure, could be harvested without additional incisions, and avoided the cost and availability issues of synthetic grafts.[11] Autologous fascia is also biocompatible, has minimal donor site morbidity, and allows secure suturing to the native dura, all of which are favorable for long-term dural integrity and prevention of CSF-related complications that can interrupt rehabilitation[13].

The thoracolumbar fascia does not directly trigger spinal metabolism but aids in the repair of soft tissues, preventing injuries from worsening by stabilizing the area, safeguarding nerves, and improving the repair of immune cells and nerves if those cells are present in the fascia. The primary role of fascia is to offer protection, aiding in the healing of the spine.[14] Several lines of evidence suggest potential benefits such as safe because >50% of patients who had non-compressive pseudomeningoceles were repaired in about 5-6 months, and the procedure had minimal CSF leakage. Compared to dural + bony decompression, it slightly reduces intraspinal pressure by about 10 mmHg, also increasing spinal cord perfusion pressure.[7,15,16] Those techniques may fix the ASIA score in patients with tSCI, duraplasty produces superior outcomes in terms of physio-radiological parameters by increasing the space surrounding the damaged spinal cord.[6] We chose thoracolumbar fascia for graft in this patient. Similar to an inadequate craniectomy, in small duraplasties, the swollen spinal cord may be restricted at the dural edges while the oedema expands. On the other hand, larger duraplasties are more frequently linked to complications for defect more than 5 cm, such as; pseudomeningoceles, CSF leakage, and prolonged hospitalization.[17]

Although MRI was available in our centre, postoperative imaging was not performed because the patient exhibited no clinical signs suggestive of CSF leakage or pseudomeningocele. Clinical indicators such as a dry, intact surgical wound without fluid drainage, absence of postural headache, and no new neurological deficits are widely recognized as reliable markers for assessing the integrity of dural repair in spinal surgery.[18,19] Functional neurological recovery was monitored using the ISNCSCI / AIS, which remains the standard for tracking neurological changes over time and guiding prognosis in spinal cord injury management.[20,21] In our patient, baseline ASIA grade B with a lower extremity motor score of 0/50 improved to ASIA grade C by month 4, accompanied by near-normal sensory recovery and partial motor return. The brief, unstained antigravity movement (~2 seconds) observed at month 4 is consistent with early reinnervation and residual muscle weakness due to prolonged disuse and denervation atrophy, which are common in thoracolumbar SCI and typically improve with ongoing, task-specific neurorehabilitation.[22] If clinical signs of CSF leakage or neurological deterioration had emerged, MRI (with or without CT myelography) would have been performed to evaluate for pseudomeningocele, residual compression, or graft failure.[18,23]

Recovery of motor endurance in traumatic spinal cord injury (SCI) depends largely on the initial severity of neurological impairment, the injury level, and the absence of residual cord compression after surgery. Patients with complete cord transection (AIS A) rarely show functional recovery regardless of dural repair technique, as demonstrated in Lim et al. (2021)[24], where a T11–T12 complete transection patient showed no improvement after 4 years despite dural closure. In contrast, patients with incomplete injuries such as our

Table 2. Cases reporting clinical outcomes after dural repair in spinal cases

Reference (Author, Year)	Case(s) / Setting	Dural repair technique	Neurologic / clinical outcome (motor/sensory / ASIA if reported)	Follow-up
Lim D. (2021) — *Medicine (Baltimore).*	Single case: 53-y male, T11–T12 fracture-dislocation with complete cord transection.	Spinal fusion, decompression and repair of dural sac to prevent CSF leak (autobone graft for fusion).	No neurological recovery immediately or at 4-year follow-up (ASIA A at presentation and persisted). (Shows outcome when cord transection is complete.)	4 years.
Lee D-H et al. (2016) — *Korean J Spine / e-Neurospine* **(Double-layer duraplasty technical note & case).**	1 case: 47-y female with large inaccessible ventral dural defects after thoracic decompression (OPLL case) → cord compression from CSF collection.	Double-layer duraplasty (intradural + epidural Lyoplant patch) ± fat graft; lumbar drain used.	Motor power improved markedly (preop: R 1/5, L 2/5 → postop at 6 wk R 3/5, L 4/5). Postop MRI at 2 & 16 months: no cord compression / no leak.	16 months (MRI at 2 & 16 mo).
Policicchio D. et al. (Policicchio et al., 2024) — *Surgical Neurology International*	Two case reports of penetrating spinal stab wounds with dural tear/CSF fistula (levels D3–D4 and D11–D12).	Indirect repair using pedicled multifidus muscle flaps to cover/repair dural defects (when direct suture not feasible).	Both patients showed partial neurological recovery post-op. Example: one patient improved from plegia/paretic state to AIS C at 6 months (documented motor improvement and resolved CSF fistula).	6 months (reported)

case (AIS B at presentation) retains some spared neural pathways, enabling potential neurological recovery with structured rehabilitation.

Our patient's early postoperative endurance of only ~2 seconds in antigravity contraction at 4 months is compatible with partial reinnervation and deconditioning seen in the early recovery phase of thoracolumbar SCI. This trajectory aligns with cases of penetrating spinal injuries with dural tear repair, such as Policicchio et al. (2024)[12], where patients improved from plegia to (AIS C) over 6 months, and Lee et al. (2016)[25], where motor power improved from 1–2/5 to 3–4/5 by 6 weeks after augmented duraplasty. Regarding QoL, the role of dural repair is indirect, it prevents persistent CSF leakage, pseudomeningocele, and wound complications that may interrupt rehabilitation and worsen patient outcomes. Therefore, the thoracolumbar fascia graft supports functional recovery by maintaining dural integrity and enabling uninterrupted rehabilitation, rather than claiming a direct QoL improvement. While formal QoL instruments.[26] were not applied in this case, prevention of CSF-related complications is supported in the literature as a key prerequisite for optimal functional recovery. Postoperative CSF leaks have been associated with increased morbidity, delayed mobilization, wound complications, and cerebrospinal sequelae that may hinder rehabilitation progress and extend hospital stay.[27]

To contextualize our results, we compared our case with other published cases and series of spinal dural tear repair **[Table.2].** These reports demonstrate that autologous graft augmentation is associated with low postoperative CSF leak rates and, in incomplete SCI, can be accompanied by neurological improvement during follow-up.

This case report has several limitations. First, the diagnosis and postoperative evaluation of the dural tear relied primarily on intraoperative findings and serial clinical assessments, without adjunctive imaging such as MRI or CT myelography. While this approach is supported in selected trauma cases with clear intraoperative confirmation, it may limit the detection of subclinical cerebrospinal fluid (CSF) leakage or pseudomeningocele formation. Second, objective measurements of spinal cord metabolism, perfusion, or CSF outflow; such as intradural pressure monitoring were not performed, thus the functional integrity of the spinal cord and graft patency were inferred from indirect clinical parameters (e.g., ASIA score progression, wound status). Third, no standardized patient-reported outcome measures (PROMs) or QoL questionnaires were used, making comparison with other reports more challenging. Fourth, long-term follow up beyond four months was not available, limiting assessment of sustained neurological recovery or late complications

Conclusion

This case illustrates that autologous thoracolumbar fascia grafting can be a viable option for repairing large posterior dural defects when primary closure is not feasible. Neurological improvement was observed over a 4-month period, although full functional recovery was not achieved. These findings are descriptive and should be interpreted in the context of the natural history of spinal cord injury. Larger cohort studies are needed to determine the comparative effectiveness of this technique on long-term neurological and quality-of-life outcomes.

Ethics approval

Our institution has exempted ethical approval from reporting this case.

Acknowledgments

All authors equally contributed to case identification, manuscript drafting, and revision.

Competing interests

All the authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems

References

1. Jazayeri SB, Maroufi SF, Mohammadi E, Dabbagh Ohadi MA, Hagen EM, Chalangari M, Jazayeri SB, Safdarian M, Zadegan SA, Ghodsi Z, Rahimi-Movaghar V. Incidence of traumatic spinal cord injury worldwide: A systematic review, data integration, and update. World Neurosurg X. 2023 Feb 1;18:100171.
2. Alizadeh A, Dyck SM, Karimi-Abdolrezaee S. Traumatic Spinal Cord Injury: An Overview of Pathophysiology, Models and Acute Injury Mechanisms. Front Neurol. 2019 Mar 22;10:282.
3. Greenberg M. *Greenberg Handbook of Neurosurgery*. Vol 53.; 2019.
4. Solou M, Politis AA, Ydreos I, et al. Posterior spinal decompression in adults with spinal cord injury without traumatic compromise of the spinal canal: what is the data?. Front Neurol. 2023;14:1220598.
5. Jo DJ, Kim KT, Lee SH, Cho MG, Seo EM. The Incidence and Management of Dural Tears and Cerebrospinal Fluid Leakage during Corrective Osteotomy for Ankylosing Spondylitis with Kyphotic Deformity. J Korean Neurosurg Soc. 2015 Jul;58(1):60-4.
6. Esparza-Mendez Gerardo A., Tapia-Carrillo Manuel, Tapia-de Santillan Zabdi, Ambrosio-Vicente Manuel. Muscle fascia graft as a potential treatment for cervical dura defects: A case report of a C2-C3 dumbbell schwannoma. Rev. med. Hosp. Gen. Méx. 2022 Jun; 85(2): 101-104.
7. Tang R, Mao S, Li D, Ye H, Zhang W. Treatment and Outcomes of Iatrogenic Cerebrospinal Fluid Leak Caused by Different Surgical Procedures. World Neurosurg. 2020;143:e667-e675.
8. Zhou HS, Pi Y, Wang C, Ao J, Sun L, Yuan H. Traumatic spinal cord injury caused by a dagger in the spine: A case report. Ibrain. 2022;8(3):406-412.
9. Gibson JNA, Waddell G. Surgery for degenerative lumbar spondylosis: Updated Cochrane review. Spine (Phila Pa 1976). 2005;30(20):2312-2320.
10. Choi EH, Chan AY, Brown NJ, Lien BV, Sahyouni R, Chan AK, Roufail J, Oh MY. Effectiveness of Repair Techniques for Spinal Dural Tears: A Systematic Review. World Neurosurg. 2021 May; 149:140-147.
11. Dong RP, Zhang Q, Yang LL, Cheng XL, Zhao JW. Clinical management of dural defects: A review. World J Clin Cases. 2023 May 6;11(13):2903-2915.
12. Policicchio D, Boccaletti R, Casu G, Mingozzi A, Muggianu G, Nodari G, Sias WM, Dipellegrini G. Pedicled multifidus muscle flaps to treat dural tears due to penetrating spinal stab wounds: Two case reports and a literature review. Surg Neurol Int. 2024 Jan 19;15:19.
13. Barber SM, Fridley JS, Konakondla S, Nakhla J, Oyelese AA, Telfeian AE, Gokaslan ZL. Cerebrospinal fluid leaks after spine tumor resection: avoidance, recognition and management. Ann Transl Med. 2019 May;7(10):217.
14. Yang S, Tang J, Yang Z, Jin H, Wang Q, Wang H. Effect of thoracolumbar fascia injury on reported outcomes after percutaneous vertebroplasty. Front Surg. 2024 May 16;11:1379769.
15. Clavien PA, Barkun J, De Oliveira ML, et al. The clavien-dindo classification of surgical complications: Five-year experience. Ann Surg. 2009;250(2):187-196.
16. D'Antona L, Jaime Merchan MA, Vassiliou A, et al. Clinical Presentation, Investigation Findings, and Treatment Outcomes of Spontaneous Intracranial Hypotension Syndrome: A Systematic Review and Meta-analysis. JAMA Neurol. 2021;78(3):329-337.
17. Song Y, Li S, Song B, et al. The pathological changes in the spinal cord after dural tear with and without autologous fascia repair. Eur Spine J. 2014;23(7):1531-1540.
18. Jiang L, Budu A, Khan MS, Goacher E, Kolias A, Trivedi R, Francis J. Predictors of Cerebrospinal Fluid Leak Following Dural Repair in Spinal Intradural Surgery. Neurospine. 2023 Sep;20(3):783-789.
19. Anselmi L, Anania CD, Ubezio MC, Farinaro G, Creatura D, Ortolina A, Tomei M, Baram A, Fornari M. Cerebrospinal Fluid Leak Prevention in Intradural Spine Surgery: A Long Series Analysis of Closure with Non-Penetrating Titanium Clips. Brain Sciences. 2024; 14(12):1223.
20. Hsieh, S., Gibbs, K. Performing and Interpreting the ISNCSCI/ ASIA Exam for Spinal Cord Injury Classification. Curr Phys Med Rehabil Rep 13, 14 (2025).
21. NASCIC. The ASIA Impairment Scale. SCI Knowledge Base. March 2025.
22. Harvey LA. Physiotherapy rehabilitation for people with spinal cord injuries. J Physiother. 2016;62(1):4–11.
23. Fehlings MG, Tetreault LA, Wilson JR, et al. A Clinical Practice Guideline for the Management of Acute Spinal Cord Injury: Introduction, Rationale, and Scope. Global Spine Journal. 2017;7(3_suppl):84S-94S.

24. Lim DJ. Intraoperative finding and management of complete spinal cord transection after thoracolumbar traumatic fracture-dislocation: A case report. Medicine (Baltimore). 2021 Jan 15;100(2):e24096.
25. Lee DH, Kim KT, Park JI, Park KS, Cho DC, Sung JK. Repair of Inaccessible Ventral Dural Defect in Thoracic Spine: Double Layered Duraplasty. Korean J Spine. 2016 Jun;13(2):87-90.
26. Cardile D, Calderone A, De Luca R, Corallo F, Quartarone A, Calabrò RS. The Quality of Life in Patients with Spinal Cord Injury: Assessment and Rehabilitation. Journal of Clinical Medicine. 2024; 13(6):1820.
27. Kinoshita H, Hongo M, Kobayashi T, Kasukawa Y, Kikuchi K, Kudo D, Kimura R, Ono Y, Kasama F, Miyakoshi N. Dural Injury During Spinal Surgery and Postoperative Cerebrospinal Fluid Leakage: A Single-Center Experience. Cureus. 2024 Oct 19;16(10):e71878.