Korean J Neurotrauma. 2025 Jan;21(1):53-59
https://doi.org/10.13004/kjnt.2025.21.e5
pISSN 2234-8999·eISSN 2288-2243

KJNT

Case Report

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Unexpected Cervical Cord Injury During Intradiscal Electrothermal Therapy for Disc Herniation

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OPEN ACCESS

Received: Nov 17, 2024
Revised: Dec 25, 2024
Accepted: Jan 10, 2025
Published online: Jan 23, 2025

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Funding
No funding was obtained for this study.

ABSTRACT

Intradiscal electrothermal therapy (IDET) is a minimally invasive procedure that alleviates chronic discogenic pain by delivering controlled heat to modify collagen and destroy pain-conducting nerve endings. While IDET offers a less invasive alternative to surgery, it carries risks such as nerve damage, infection, vertebral osteonecrosis, and, rarely, spinal cord injury. This report presents the case of a 36-year-old woman who developed left-sided hemiparesis following IDET for cervical disc herniation at the C5/6 level. Magnetic resonance imaging revealed cervical cord edema, and examination revealed neurological deficits, including reduced proprioception, motor strength, and senses of pain and temperature. Anterior cervical discectomy and fusion led to thermal injury on the left ventral spinal cord, and postoperative recovery resulted in significant neurological improvement, although some sensory deficits persisted. This case underscores the importance of appropriate patient selection and meticulous procedural technique to prevent severe complications, emphasizing the importance to reserve IDET for specific cases and to consider alternatives for more complex spinal conditions.

Keywords: Intradiscal electrothermal therapy; Spinal cord injuries; Complications; Disc herniation

INTRODUCTION

Intradiscal electrothermal therapy (IDET) is a minimally invasive procedure aimed at treating chronic pain resulting from discogenic issues.[1] The procedure involves the insertion of a navigable catheter into the intervertebral disc to deliver controlled thermal energy, with the goal of modulating the collagen properties and destroying the nociceptive nerve endings.[7] However, this technique has been associated with various complications, including nerve damage, infection, discitis, vertebral osteonecrosis[6,8] and, in rare cases, cord injury. Here we present a case of cervical cord injury occurred following IDET.

Conflict of Interest
The authors have no financial conflicts of interest.

Informed Consent
Written informed consent was waived by the Institutional Review Board.

Ethics Approval
This case report was carried out following approval from the Institutional Review Board of the hospital (NR-IRB 2024-012, approval date: August 30th 2024).

CASE REPORT

A 36-year-old female presented to the outpatient clinic with a chief complaint of left-sided hemiparesis. In April 2024, she experienced left posterior neck pain without any cause of trauma and was diagnosed with herniation of cervical disc towards the left on C5/6 level (**FIGURE 1**). The patient received IDET at a local clinic (**FIGURE 2**) and after the procedure, she suddenly developed left-sided hemiparesis. The magnetic resonance imaging (MRI) taken at this time (**FIGURE 3**) revealed a newly-developed high signal intensity along the cervical spinal cord.

On examination, she had left-sided hemiparesis with an medical research council scale of grade 3 on the upper extremity and grade 4 on the lower extremity. The patient showed a decreased proprioception on the ipsilateral side and a decreased sense of pain and temperature on the contralateral side. She also showed mild urinary retention and a positive Hoffmann's sign on the left side. Her modified Japanese Orthopedic Association (mJOA) score was 12, indicating a moderate myelopathy.

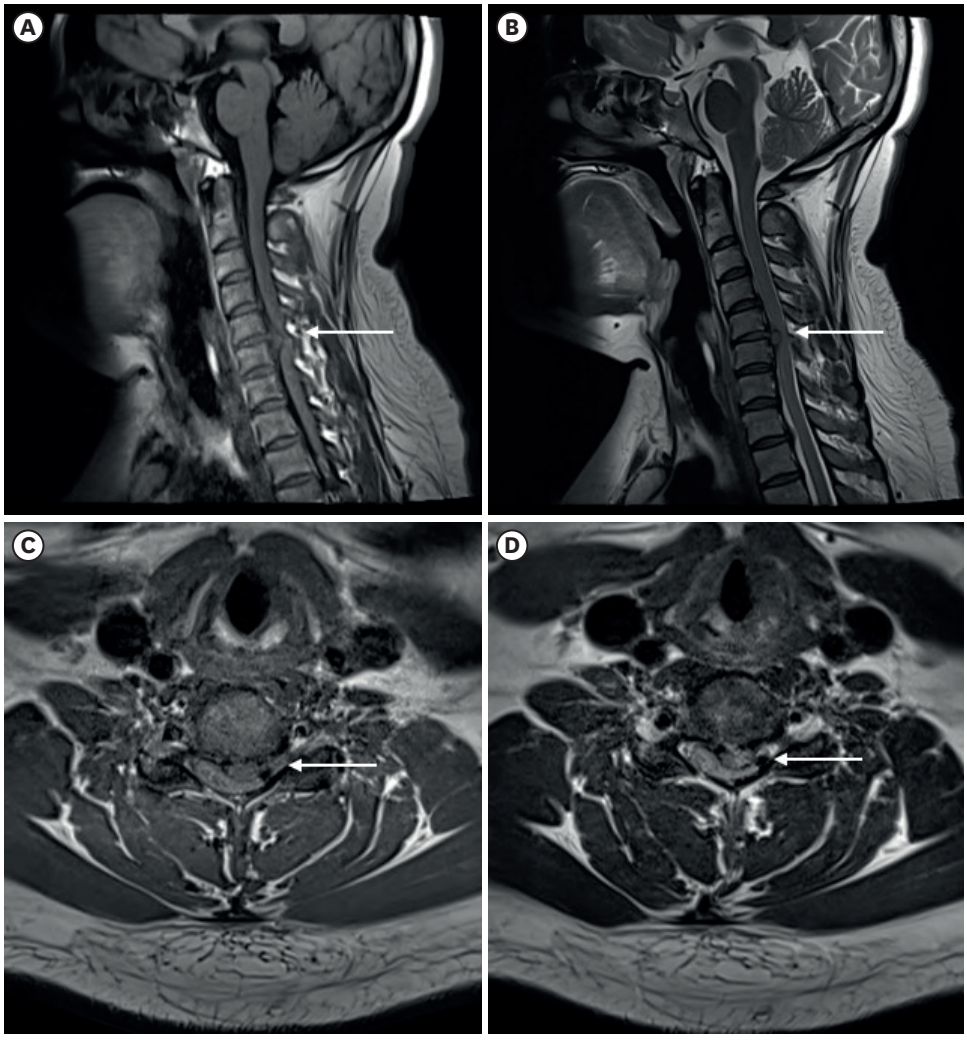

FIGURE 1. The initial magnetic resonance images taken before intradiscal electrothermal therapy. The initial T1-weighted (A, C) and T2-weighted (B, D) magnetic resonance images taken in April, 2024 show a herniation of cervical disc towards the left on C5/6 level (white arrows).

https://doi.org/10.13004/kjnt.2025.21.e5

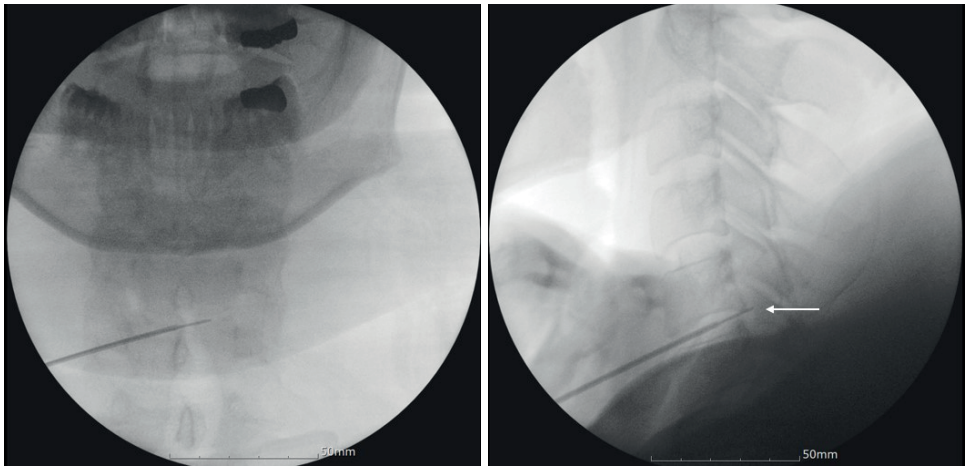

FIGURE 2. The fluoroscopy image shows an intradiscal electrothermal therapy procedure performed at a local clinic. The treatment aimed to target the herniated disc at the left side of C5/6; however, the catheter tip was mispositioned within the spinal canal (white arrow).

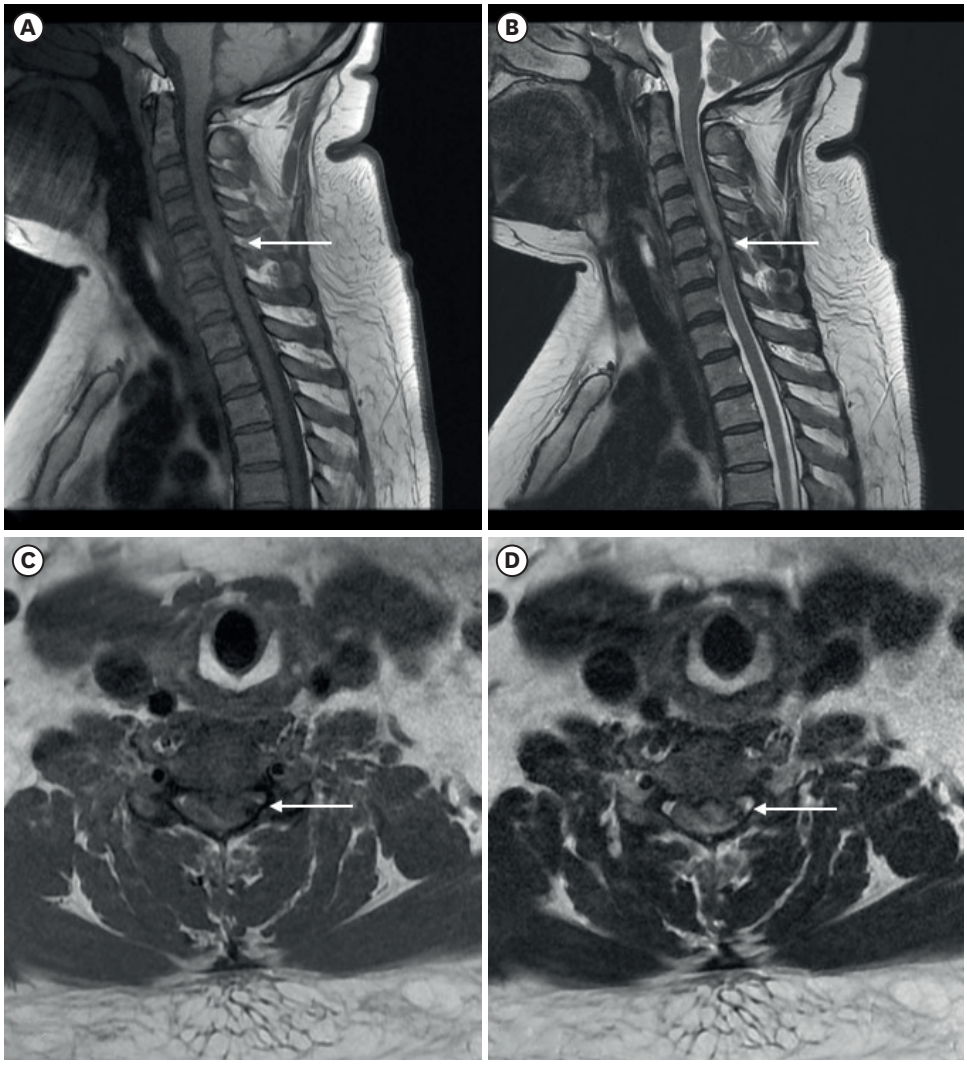

FIGURE 3. The magnetic resonance images taken after intradiscal electrothermal therapy. The T1-weighted (A, C) and T2-weighted (B, D) taken after intradiscal electrothermal therapy reveal a newly-developed high signal intensity along the cervical spinal cord and herniated disc (white arrows).

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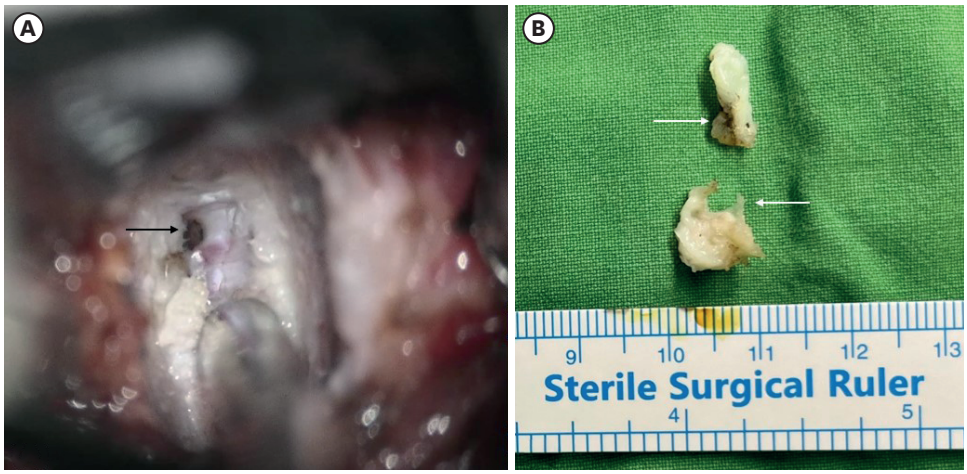

FIGURE 4. Intraoperative findings during anterior cervical discectomy and fusion. (A) Intra-operative image during anterior cervical discectomy and fusion shows a dural defect with a burn mark on the left ventral side of the cervical cord (black arrow). (B) Herniated disc fragments with round-shaped defect and burn mark (white arrows) shows the evidence of intradiscal electrothermal therapy.

She was consented and scheduled for anterior cervical discectomy and fusion (ACDF) on C5/6 along with intravenous steroid therapy. Under general anesthesia, ACDF on C5/6 was performed. After removing the disc fragment, there was a dural defect with a burn mark on the left ventral side of the cervical cord (**FIGURE 4**). The dural defect was covered by a fibrinogen/thrombin-based collagen fleece (TachoSil®; Takeda Austria GmbH, Linz, Austria) and after the operation, the patient recovered well with improved neurological conditions. Her mJOA score was improved to 16, implying mild myelopathy.

DISCUSSION

IDET is a minimally invasive procedure used to treat symptomatic patients with annular disruption or contained disc herniations. This technique delivers thermal energy directly to the annular wall and disc nucleus through a flexible and controllable intradiscal catheter, aiming to induce controlled coagulation and shrinkage of collagen tissue. Thus, this process reduces the volume of the nucleus pulposus impinging on neural elements and potentially strengthens the annulus.[1,5]

IDET has been advocated as an alternative to both conservative care and invasive surgery in patients with discogenic pain because of its minimally invasive nature and low morbidity.[3] However, the exact mechanism by which heating reduces discogenic pain remains unclear. Numerous theories have been proposed regarding how IDET works. These include altering spinal segment mechanics through collagen modification, coagulating annular nociceptors to contract collagen, mediating inflammation biochemically, stimulating outer annular healing, inducing healing of annular fissures, reducing intradiscal pressure, and cauterizing vascular ingrowth. Despite these theories, none have been conclusively proven.[9]

IDET is not recommended for patients with severe disc degeneration, extruded or sequestered herniated discs, radiculopathy, spinal stenosis, or spinal instability, such as spondylolisthesis. Additionally, this procedure is unsuitable for those who have undergone previous lumbar spine surgery or IDET at the same level within the last 6 months.[4] In this

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case report, the patient had a large cervical disc herniation, making IDET an unsuitable option.

Complications may develop after the procedure and various adverse effects have been reported, necessitating a thorough understanding of the associated risks. One of the primary complications of IDET is thermal damage. Several complications related to thermal injury have been reported and thermal nerve injury is especially common.[6] In the cadaveric studies, if the catheter is properly positioned, the effective heating within the targeted regions of the intervertebral disc, particularly the posterior annulus, is ensured.[2] In addition, there is a low risk of undesired delivery of thermal energy along the endplates and anterior annulus.[10] However, during the procedure, the catheter used to deliver thermal energy can inadvertently affect nearby structures. Thermal injury on endplate leads to osteonecrosis and injury on neural structures leads potentially leading to neuropathic pain or sensory deficits.[6,8] This risk underscores the need for precise technique and careful navigation to avoid unintended thermal injury to the spinal nerves.

The potential mechanism for cervical cord injury following IDET is the inadvertent thermal injury to the spinal cord. The proximity of the cervical spinal cord to the cervical intervertebral discs increases the risk of thermal damage during the procedure. Additionally, technical difficulties in the application of this method can lead to unintended thermal spread and subsequent spinal cord injury.

In this case, IDET was intended to target the herniated disc on the left side of the C5/6 level. However, the catheter tip was mispositioned within the spinal canal, increasing the risk of cord injury (**FIGURE 2**). Even if the catheter had initially been properly positioned over the herniated disc, the application of thermal energy could cause the herniated disc to shrink. This shrinkage might displace the catheter tip further into the spinal canal, potentially penetrating the dura and causing thermal injury to the cervical cord. While a properly positioned catheter may reduce the risk of thermal injury, precise and careful navigation of the catheter tip within the disc, along with consideration of potential disc shrinkage, is crucial to avoid unintended thermal damage.

As a result of IDET, the patient sustained an injury on the left ventral side of the cervical cord. Based on the patient's neurological examination, IDET gave a direct injury on the left spinothalamic tract which caused a decreased sense of pain and temperature on the right side. Cervical cord edema due to IDET affected the left corticospinal tract and the dorsal column tract which resulted in left hemiparesis with decreased proprioception. Post-ACDF MRI showed complete removal of the disc fragment with resolving cervical cord edema (**FIGURE 5**). After the operation, such decreased sense of pain and temperature on the right side resulting from direct injury by IDET was left unchanged but left-sided weakness and proprioception improved as the cord edema decreased.

CONCLUSION

This case underscores the potential risks associated with IDET, particularly in cases where it is used inappropriately. Although IDET is a minimally invasive option for treating discogenic pain, it can lead to serious complications, such as thermal injury to the spinal cord, as seen in this patient. The development of cervical cord injury in this case highlights the importance of

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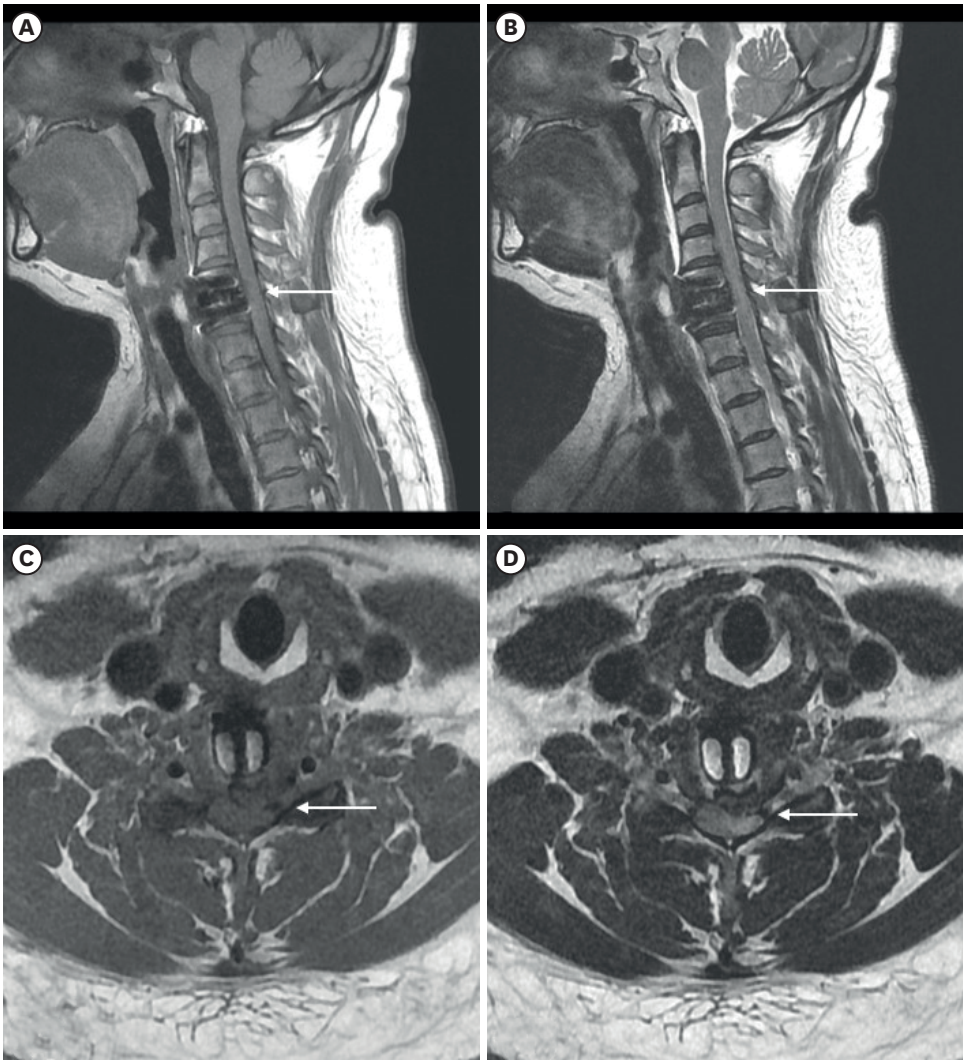

FIGURE 5. The magnetic resonance images taken after anterior cervical discectomy and fusion. The T1-weighted (A, C) and T2-weighted (B, D) magnetic resonance images taken after anterior cervical discectomy and fusion show a complete removal of herniated disc on C5/6 and such decrease in a high signal intensity along the cervical spinal cord (white arrows).

careful patient selection and procedural precision. IDET should be reserved for cases where the benefits clearly outweigh the risks, and alternative treatments should be considered for patients with more complex spinal conditions. In addition, this case illustrates the critical role of timely surgical intervention in managing IDET-related complications, as the patient's neurological function showed significant improvement following ACDF. Moving forward, clinicians should remain vigilant about the potential adverse outcomes of IDET and ensure thorough preoperative evaluation and postoperative monitoring.

ACKNOWLEDGMENTS

The authors deeply appreciate the kindness of the patient and her family for consent to publication and use of photographs.

https://doi.org/10.13004/kjnt.2025.21.e5

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