

Minimally invasive percutaneous endoscopic foraminotomy and discectomy in a French Bulldog with intervertebral disc extrusion

Tanhatai Krajarngjang^{1*} Luksamee Limpongsai¹ Panutda Darapong¹
Woraphanit Sonbanpai¹ Mataya Taweechart¹

Abstract

A six-year-old female French Bulldog was referred for neurological diagnostic tests and treatment for progressive paraparesis over an 8-day period. The dog had a history of intervertebral disc extrusion (IVDE) surgical correction two years prior. Neurological examination revealed T3–L3 myelopathy. Magnetic resonance imaging of the thoracolumbar spine confirmed IVDE with spinal cord compression at T13–L1. A minimally invasive percutaneous endoscopic foraminotomy and discectomy (PEFD) was performed to remove the extruded disc material. The patient regained the ability to stand and showed voluntary limb movement 48 hours post-surgery. At the 4-week follow-up, the patient showed a complete recovery to her baseline neurological status. No complications were reported. Beyond a smaller incision, minimally invasive spinal surgery (MISS) offers advantages, including reduced muscular trauma, minimal blood loss, and decreased postoperative pain. Furthermore, the magnification and illumination provided by MISS offer superior visualization compared to conventional open surgery, presenting an advantage for procedures in delicate areas requiring high precision.

Keywords: discectomy, dog, foraminotomy, intervertebral disc extrusion, minimally invasive spinal surgery, percutaneous

¹Arak Animal Hospital, Bangkok 10110, Thailand

*Correspondence: paurn_tanhatai@hotmail.com (T. Krajarngjang)

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Introduction

Hansen type I intervertebral disc disease (IVDD) is the most common neurological disorder, accounting for 45.5% of cases in French Bulldogs. The thoracolumbar region was affected in 60.2% of cases (Mayousse *et al.*, 2017). A recent study showed that recurrence occurs in more than half of French Bulldogs affected by IVDD (Leu *et al.*, 2023). According to the 2022 American College of Veterinary Internal Medicine (ACVIM) consensus statement, surgical management might be considered for young, active dogs with multiple mineralized discs, especially in cases of recurrent episodes. Furthermore, surgical decompression can be considered when neurological deficits are progressive, non-responsive to conservative treatment, or when pain persists despite appropriate medical management (Olby *et al.*, 2022).

MISS has grown rapidly since the end of the 20th century (Mayer, 2006). In veterinary medicine, two methods are utilized, including percutaneous endoscopy (PE) and tubular retractors with microscopic operation (MO) (Hettlich, 2018). Comparatively, PE techniques are less invasive than tubular retractor-assisted MO. Regarding previous PE spinal surgery studies, Hwang (2016) presented the operative techniques of PE thoracolumbar pediculectomy in 10 normal dogs in 2016. Moon (2017) presented the operative techniques of PE mini-hemilaminectomy in 7 cadavers in 2017. Sakamoto (2021) were the first to describe a successful treatment of vertebral hypertrophy using PE surgery in 2021. Recently, Lee (2024) presented the PE thoracolumbar foraminotomy in 6 large breed dog cadavers in 2024.

These studies demonstrated the feasibility of PE spinal surgery for decompression and allowed for adequate visualization of the spinal canal (Hwang *et al.*, 2016; Moon *et al.*, 2017). Furthermore, PE can reduce tissue damage, is less invasive than open surgery, and may provide a favorable prognosis (Sakamoto *et al.* 2021; Lee *et al.*, 2024). To the authors' knowledge, this represents one of the first clinical case reports describing the use of percutaneous endoscopic foraminotomy and discectomy (PEFD) for intervertebral disc extrusion (IVDE) in a dog.

Case Description

A six-year-old spayed female French Bulldog weighing 17.5 kg was presented with a one-week history of progressive non-ambulatory paraparesis and mild spinal hyperesthesia. The dog had undergone surgical treatment for intervertebral disc extrusion 2 years previously and regained ambulation with mild pelvic limb ataxia, which remained stable until the onset of the current episode one week prior. Postural reactions were absent in both pelvic limbs. Spinal reflexes and deep pain perception were intact. Neurological signs indicated a lesion localized between the T3 and L3 spinal cord segments. Radiographs of the thoracolumbar spine showed hemivertebrae at T6–T8.

Magnetic resonance imaging (MRI) of the thoracolumbar spine was performed using a 1.5-Tesla

unit (Signa Prime 1.5T; GE Healthcare, Thailand). The acquired sequences included sagittal and transverse T1-weighted (T1W), T2-weighted (T2W), T2*-weighted gradient-recalled echo (GRE), short tau inversion recovery (STIR) and contrast-enhanced T1W sequences. On MRI, the intervertebral disc at T13–L1 was dorsally and leftward extruded, severely compressing the spinal cord (Fig. 1a-b). The left epaxial muscles at the L1–L3 level were retracted, irregularly arranged, and infiltrated with fatty tissue, accompanied by a loss of left-sided vertebral laminar bones, consistent with the previous surgical site (Fig. 2c-e).

Based on the inadequate response to conservative therapy and the diagnostic findings of severe spinal cord compression, the dog was scheduled for surgical decompression via PEFD. Premedication was performed with diazepam (0.2 mg/kg, IV), and anesthesia was induced using propofol (4 mg/kg, IV), and maintained with isoflurane (1–1.5%) in oxygen. Preoperative analgesia consisted of morphine (0.4 mg/kg, IM), lidocaine (1 mg/kg, IV), and ketamine (0.5 mg/kg, IV). During surgery, a constant rate infusion (CRI) of morphine (0.24 mg/kg/hr), lidocaine (3 mg/kg/hr), and ketamine (0.6 mg/kg/hr) was administered for intraoperative analgesia. Perioperative antibiotic prophylaxis consisted of cefazolin sodium (20 mg/kg, IV), repeated every 90 minutes. Vital signs remained stable throughout the surgery.

The operating room was configured to accommodate a C-arm (OEC 9600; GE Healthcare, Thailand) and the endoscopic system. The dog was positioned in oblique sternal recumbency (at approximately 45 degrees) to facilitate endoscope manipulation. The operative site was then prepared aseptically. A left-sided approach to the T13–L1 intervertebral foramen was planned to perform PEFD and expose the ventrolateral aspect of the spinal cord.

A 1.5-cm parasagittal skin incision was made over the L1 vertebral region. Under fluoroscopic guidance, a Kirschner wire (K-wire) was advanced through the subcutaneous fat, lumbodorsal fascia, and longissimus lumborum muscle until it contacted the bone. The wire was directed toward the L1 pedicle, beneath the base of the L1 articular process.

A dilator (7.0-mm diameter; Elliquence, New York, USA) was advanced over the K-wire, and an endoscopic working tube (8.0-mm outer diameter; Elliquence) was subsequently placed over the dilator. The dilator was then removed and replaced with spinal endoscope (7.0-mm diameter, 4.3-mm working channel, 130-mm length, 30° view; Elliquence). Karl Storz Endoscopy (Tuttlingen, Germany) manufactured the light source, camera control unit, and camera head. Accurate placement of instruments was confirmed via fluoroscopy (Fig. 2).

Remaining muscle tissue between the bone and the endoscopic tip was removed using a radiofrequency plasma surgical system (ARS700; Bonss Medical Technology, China) and a blunt dissector (Fig. 3a-b). Upon exposing the bony surface of the L1 pedicle, a foraminotomy was performed using an electric drill

(P200-RA330-L, Primado2; NSK, Japan) fitted with a 2.5-mm coarse diamond burr. Drilling progressed from the outer cortical bone through the cancellous bone. Once the inner cortical bone was adequately visualized, it was gently removed using diamond burrs to expose the spinal canal (Fig. 3c-g). Hemostasis was achieved by redirecting the endoscope view to an alternative position for a few minutes (Fig. 3h).

Elevation of the spinal cord and nerve roots was identified. Removal of the extruded disc material and partial discectomy were achieved via outer-part drilling (Fig. 3i). The endoscopic discectomy was performed using a nerve hook and grasping forceps (Fig. 3j-n). Complete decompression was confirmed using direct endoscopic inspection and nerve hook; specifically, the nerve hook was advanced beneath the spinal cord toward the contralateral spinal canal to verify the total elimination of the compressive lesion (Fig. 3).

The subcutaneous tissues and skin were sutured routinely. The total procedure time, measured from incision to closure, was approximately 175 minutes. Postoperatively, the incision length was measured at 1.7 cm (Fig. 4).

Postoperative analgesia included tramadol (3 mg/kg, SC) administered every 8 hours for the first 24 hours, with subsequent doses determined based on pain score reassessments. The patient was

prescribed firocoxib (6.5 mg/kg, PO, SID) for anti-inflammatory purposes and gabapentin (9 mg/kg, PO, TID) for neuropathic pain control. These medications were administered for 3 days. Amoxicillin/clavulanate (21 mg/kg, PO, BID) was administered for one week following the operation.

The patient was hospitalized for one week for postoperative monitoring and neurological assessment. Cage rest was enforced to prevent a recurrence of spinal cord compression. Rehabilitation was initiated on the third postoperative day to promote healing and restore motor function (Fig. 4).

No intraoperative or postoperative complications were observed. The patient made a smooth recovery, with progressive neurological improvement in the pelvic limbs. The dog regained the ability to ambulate by postoperative day 2. Postoperative proprioceptive testing revealed delayed responses bilaterally on day 2. By day 6, proprioception had normalized in the left pelvic limb but remained delayed in the right pelvic limb. Proprioceptive responses showed improvement compared to the initial presentation. However, due to the history of previous spinal surgery and the lack of a baseline neurological assessment prior to the current episode, a direct comparison could not be established. Nevertheless, according to the owner's observations, the dog's gait eventually returned to its pre-recurrence functional status.

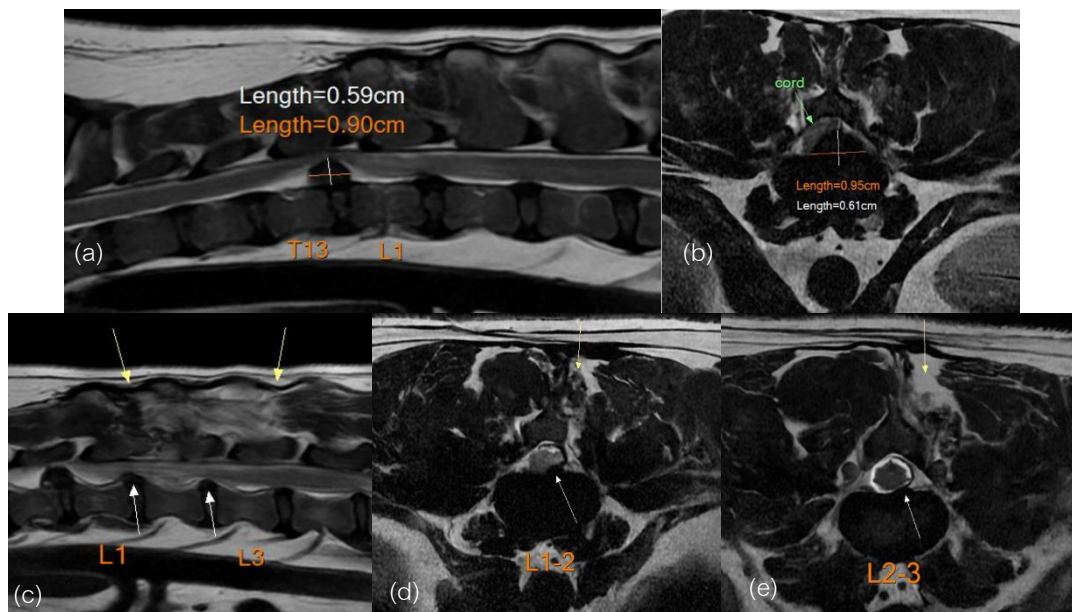


Figure 1 MRI findings of IVDE at T13-L1. (a) T2W sagittal MRI showing that the intervertebral disc at T13-L1 was dorsally extruded, severely compressing the spinal cord. (b) T2W transverse MRI showing that the intervertebral disc was dorsally and leftward extruded. (c-e) T2W sagittal and transverse MRIs showing that the intervertebral discs at L1-L3 were mildly protruded dorsally, causing mild spinal compression at the L1-L2 level. The left epaxial muscles at the L1-L3 level are retracted, irregularly arranged, and infiltrated with fatty tissue, accompanied by a loss of left-sided vertebral laminar bones, consistent with the previous surgical site.



Figure 2 A fluoroscopic image demonstrating the accurate positioning of the K-wire, endoscopic working tube, and spinal endoscope at the surgical site.

Discussion and Conclusions

In the present case, the patient was positioned in oblique recumbency, midway between sternal and lateral, with the vertebral column rotated away from the surgeon. According to Guevar and Olby (2020), this orientation provides an enhanced surgical field and superior access beneath the facet joints. Furthermore, this positioning offered superior ergonomic handling of the endoscope compared to standard sternal recumbency.

The L1 pedicle was selected as the optimal entry site for K-wire insertion due to its larger surface area, which ensures a wider margin of safety. In contrast, targeting the accessory process of T13 carries a significant risk of instrument slippage into the intervertebral foramen, potentially resulting in iatrogenic injury to the nerve root or spinal cord. The insertion of the K-wire serves strictly as an initial guide for instrument placement; subsequently, the foraminotomy was initiated by drilling at the cranial border of L1 and progressively extended toward the caudal border of T13 to completely remove the extruded disc material. Furthermore, meticulous planning of the bone opening margins using preoperative diagnostic imaging is highly recommended.

A foraminotomy was selected to manage the intervertebral disc compression in order to preserve the articular process, thereby minimizing vertebral instability (Shores and Brisson, 2017). Nevertheless, the inherent risk of hemorrhage from the vertebral vessels during the procedure remains a critical consideration.

The total operative duration was prolonged due to the surgeon's initial experience with minimally invasive spinal surgery (MISS), which occasionally

presented technical challenges during the surgical approach. Specifically, intraoperative displacement of the endoscope occurred twice during the muscle approach, necessitating repeated fluoroscopic imaging to verify and correct the instrument positioning. This represents a critical challenge for surgeons accustomed to conventional open anatomy, who may initially find endoscopic visualization unfamiliar. However, with accumulated hands-on experience, familiarity with the endoscopic anatomy will improve. As technical proficiency and procedural familiarity grow, excessive endoscopic manipulation, which can lead to accidental displacement, is expected to decrease. Furthermore, maintaining a stable and firm grip on the endoscopic assembly is essential to prevent slippage during the procedure, thereby shortening the learning curve associated with this novel surgical method.

In this case, the MISS approach was chosen to minimize tissue trauma and reduce perioperative analgesic requirements. However, prolonged anesthesia duration may adversely affect neurological recovery (Fenn *et al.*, 2020). Therefore, if an extended anesthetic time is anticipated, intraoperative conversion to conventional open surgery should be considered to facilitate better functional outcomes.

Throughout the procedure, no fluctuation in vital signs suggestive of intraoperative pain was observed. In contrast, conventional open surgery frequently involves variations in blood pressure, heart rate, and respiratory rate during muscle retraction, necessitating supplemental intraoperative analgesics or increased anesthetic depth. The MISS appeared to minimize perioperative pain. Consequently, the reduced anesthetic requirement associated with MISS may contribute to enhanced anesthetic safety for the patient.

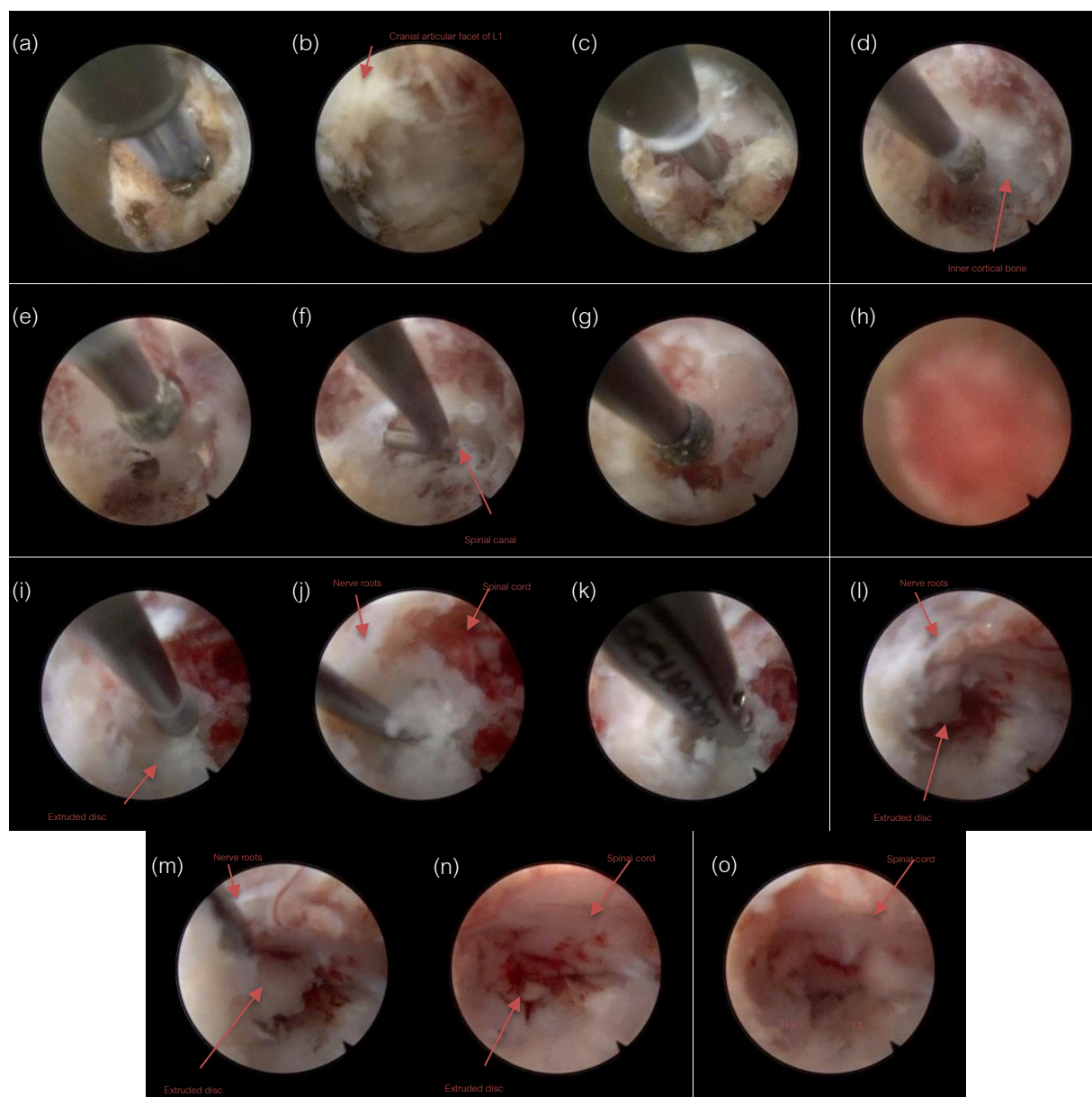


Figure 3 Intraoperative endoscopic images. (a-b) Endoscopic approach to the left-sided L1 pedicle using a radiofrequency plasma surgical system, a blunt dissector, and grasping forceps. (c-e) Foraminotomy performed using an electric drill, burring from the outer cortical bone to the cancellous bone and the inner cortical bone to expose the spinal canal. (f-g) Exploration of the exposed spinal canal using a nerve hook, followed by extension of the bone opening with a burr to a size sufficient for the procedure. (h) Intermittent bleeding from the spinal canal obscuring the endoscopic field of vision, which was managed by temporarily redirecting the endoscope to achieve hemostasis before resuming the operation. (i-k) Discectomy was achieved by drilling the outer layer of the extruded disc and fenestrating the inner calcified disc with a nerve hook and grasping forceps. (l-m) Extraction of a remaining fragment of disc material concealed beneath nerve roots using a nerve hook and grasping forceps. (n-o). Verification of the complete absence of residual spinal cord compression using a nerve hook and direct endoscopic inspection.



Figure 4 The postoperative incision length was measured at 1.7 cm, and rehabilitation was initiated on the third postoperative day to promote healing and restore motor function.

In conclusion, this case report describes clinical findings, advanced imaging features, surgical techniques, and postoperative outcomes of this procedure. It demonstrates that MISS is a feasible and effective approach for treating IVDE in dogs, providing satisfactory clinical outcomes.

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Declaration of artificial intelligence use: The authors declare that no Artificial Intelligence tools were used in the preparation, writing, analysis, or production of this manuscript.

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