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CASE REPORT
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Traumatic Lumbar Instability in a Red Fox (*Vulpes vulpes*): Evaluation of Pedicle Screw-Rod Fixation

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ABSTRACT

***Background*:** Fox injuries can occur throughout the year. The primary causes of injuries include traffic accidents, entanglement in fences or wire mesh, trapping incidents, poisoning, self-inflicted injuries from mange irritation, and attacks by domestic animals or other foxes, particularly when weakened and partially helpless due to other circumstances. This case presentation delves into the clinical and radiographic findings, anesthesia applications, surgical procedures, and prognosis of a red fox (*Vulpes vulpes*) that suffered a lumbar vertebral fracture due to trauma. It stands as a pioneering study in the literature on this specific topic.

***Case*:** An approximately 1-year-old female Red Fox (*Vulpes vulpes*) weighing 3.7 kg, presenting with hind limb paralysis. Clinical and neurological examination was conducted. Radiography and Computed Tomography imaging were performed. The neurological examination, radiological and computed tomography images confirmed a fracture in the corpus vertebra of L6. Pedicle screw-rod fixation was used to achieve stabilisation. Postoperative examinations revealed no complications. Remarkably, the fox was able to stand up on the first day post-operation and exhibited swift walking abilities. Improvement in the use of the right hind limb was noted, with the ability to exert pressure on the left hind limb. In conclusion, we posit that incorporating new data on Fox and similar species into the literature would prove advantageous for clinicians specializing in exotic animals. Furthermore, evaluating the outcomes of the pioneering Pedicle screw-rod fixation application in a fox and similar species contributes valuable insights to the existing knowledge in this field.

***Discussion*:** As this case marks the inaugural investigation into lumbar vertebral fractures in the fox, a comprehensive analysis was undertaken, drawing references from existing canine and feline literature while there are existing studies in wolves. In the observed case, a fracture of the corpus of L6 was identified. L6 fractures can cause severe low back pain, hindering standing, and surgical stabilization is often indicated. Based on the literature review, although there are many techniques, but, a specific surgical technique for treating L6 fractures in dogs remains unclear. In this case, pedicle screw-rod fixation was employed, and good fixation was observed in the postoperative period. The biomechanical advantage of these dorsally applied fixation devices lies in their resistance to ventral bending forces associated with thoracolumbar sacrocaudal luxation since the implant is positioned on the tension side of the vertebral column, limiting flexion or extension. As far as we are aware, this study represents the first documentation of traumatic spinal injuries in foxes. Introducing new data on foxes and similar species to the literature can be valuable for clinicians working with exotic animals. Additionally, the assessment of results from the application of pedicle screw-rod fixation, a procedure performed for the 1st time in a fox and similar species, would contribute to the existing knowledge in this field. The use of pedicle screw-rod application is considered to be straightforward, less invasive, and has shown favorable outcomes in the postoperative period. It has the potential to promote neurological and motor function recovery following surgery.

Keywords: patellar reflexes, pain test, sciatic reflexes, spinal fracture, luxation.

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INTRODUCTION

Fox injuries can occur throughout the year, with a higher prevalence between December and February during breeding and territorial establishment. The primary causes of injuries include traffic accidents, entanglement in fences or wire mesh, trapping incidents, poisoning, self-inflicted injuries from mange irritation, and attacks by domestic animals or other foxes, particularly when weakened and partially helpless due to other circumstances [7].

Spinal fractures and luxations (SFLs) in small animals, such as dogs, are commonly associated with severe external trauma, occurring in approximately 6% of cases with neurologic deficits indicative of spinal cord dysfunction [9]. Conservative treatment in dogs involves external immobilization with splints and bandages, cage confinement, exercise restriction, analgesia, and anti-inflammatory medications [1]. Surgical methods for spine fractures or dislocations include plate application, external fixation, Kirschner-Ehmer device, composite fixation with pins or screws, polymethylmethacrylate (PMMA), external stabilisation fixation, modified segmental spinal instrumentation, and tension band stabilisation [3,4]. Polyaxial screw applications can also be performed in cats [10].

This case presentation delves into the clinical and radiographic findings, anesthesia applications, surgical procedures, and prognosis of a Red fox (*Vulpes vulpes*) that suffered a lumbar vertebral fracture due to trauma. It stands as a pioneering study in the literature on this specific topic.

CASE

The subject of this case study was a female Red Fox (*Vulpes vulpes*), approximately 1-year-old and weighing 3.7 kg (Figure 1). The fox was rescued by fire brigade teams after falling into a well and subsequently brought to the Surgical Clinic of Selçuk University Faculty of Veterinary Medicine. The complaint presented was hind limb paraplegia, as reported by authorities from the Nature Conservation and National Parks 8th Regional Directorate.

Upon examination, the patient's overall health condition was found to be satisfactory. Subsequent to the patient assessment, a neurological examination was conducted. Nociception, patellar, cranial tibial, and sciatic reflexes were evaluated, and pain tests were administered. To facilitate the collection of blood samples and perform computed tomography (CT) imaging, sedation was achieved using medetomidine hydrochloride[1] [Domitor® - 0.1 mg/kg, IM] and butorphanol[2] [Butomidor® - 0.1 mg/kg-IM]. Induction was carried out with propofol[3] [Propofol Lipuro - 4 mg/kg, IV]. On the 1st day of admission (day 1), a complete blood count and biochemical profile were requested. The venous blood gas showed metabolic acidosis (pH 7.343; hypokalemia (3.5 mmol/L), hypernatremia (166 mmol/L); hypocalcemia (0.97 mmol/L;), hyperchloremia (122 mmol/L). The blood count showed monocytosis (1,63 m/mm^3), polycythemia (14.46 m/mm^3). Biochemical profile showed elevated SGOT parameters (222 U/L), hypermagnesemia (2.7 mg/dL), elevated LDH parameters (330 U/L), hypercholesterolemia (205 mg/dL), hyperbilirubinemia (1.2 mg/dL), hyper-GGT (6 U/L), hypoproteinemia (0.5 g/dL).

Figure 1. Female Red Fox (*Vulpes vulpes*), approximately 1-year-old and weighing 3.7 kg.

Bilateral radiographs of the skull, thorax, and abdomen were taken using the following radiological equipment[4]: Specifically, the lumbar spine was imaged in the latero-lateral and ventro-dorsal positions.

The patient was anesthetized with propofol[3]. A computed tomography (CT)[5] scan, encompassing transverse, sagittal, and dorsal views, was performed using, by CT to achieve enhanced visualization of the skull and abdomen. Following the completion of all procedures, the patient was revived with atipamezole[1] [Antisedan - 0.5 mg/kg, IM].

The patient's food intake was ceased 12 h prior to the surgery. After securing the patient in the dorsal recumbent position, intravenous access was established via the cephalic vein, and the patient was transferred to the operating room. Premedication was administered with medetomidine1 [0.1 mg/kg, IM] and butorphanol[2]

[0.1 mg/kg, IM]. Induction of anesthesia was achieved with propofol[3] [4 mg/kg, IV].

Following induction, the patient was intubated using a size 4 cuffed endotracheal tube in the sterno-abdominal position, and anesthesia was maintained with isoflurane[6] [Isoflurane - VIMA). The oxygen flow was set at 2 L/min. Throughout the anesthesia, a continuous infusion of butorphanol[2] [24 mg], medetomidine1 [0.2 mg], and ketamine[2] [Ketasol® - 60 mg] was administered [5 mL/kg/h, IV]in 500 mL isotonic solution. The patient was continuously monitored during the operation, with observations including body temperature (using a standard digital thermometer), respiration, pulse, and oxygen hemoglobin saturation (monitored with a pulse oximeter placed on the tongue).

A dorsal incision was made over the lumbar region (L5-L7) after shaving and applying aseptic and antiseptic procedures to the extensively shaved lumbar region of the prone fox. The epaxial muscles (M. longissimus dorsi, M. transversospinalis) were dissected, and a partial laminectomy was performed at the level of L6. L6 and L7 were aligned with traction. 2.0 mm polyaxial pedicle screws[7] were securely inserted into the corpus of L6 and L7, connected with a rod. The region was closed with sutures.

A reduction in nociceptive, patellar, cranial tibial, and sciatic reflexes was noted in the left hind limb, whereas the reflexes of the right hind extremity were comparatively better. The patient exhibited leg pulling during pain tests. Laboratory findings indicated an elevation in monocytes, hematocrit, SGOT, LDH, total bilirubin, and GGT values, while the protein value was observed to be decreased.

The radiographic positions of the cranium, cervical, thoracic, abdomen, and lumbar vertebrae were assessed. No abnormalities were identified in the cranium, cervical, and thoracic vertebrae. However, radiological examinations revealed a fracture/dislocation in the vertebral body of L6 within the L6-L7 spinal cord segment (Figure 2). In the abdominal interpretation, a radiopaque appearance was linked to bone fragments in the colon.

CT examination of the 0.5 mm transverse and sagittal, scans of the computed tomography revealed dislocation between L6-L7 (Figure 3).

Postoperative radiological assessment demonstrated the mutual stabilization of L6-L7. It was observed that the inserted pedicle screw and rod remained securely in place without any signs of displacement (Figure 4 A & B). Systemic antibiotic treatment with Amoxicillin/Clavulanate[8] [Synulox, 8.75 mg/kg, SC, q24h, 7 days] was administered. Meloxicam[9] [Bavet Meloxicam, 0.2 mg/kg, SC] was initiated as an analgesic and continued at [0.1 mg/kg, SC, q24h] for the next 3 days. Due to the red fox's compliance with the treatment and the absence of systemic disease, a favorable prognosis was achieved. Throughout this period, the fox was provided with a diet consisting of beef and chicken. The fox stood up on the 1st day following the operation and demonstrated the ability to walk swiftly. It was observed that she utilized the right hind limb more effectively, and she was able to apply pressure on the left hind limb. The case was hospitalized for 1 week and subsequently transferred to the zoo authorities for ongoing care and treatment.

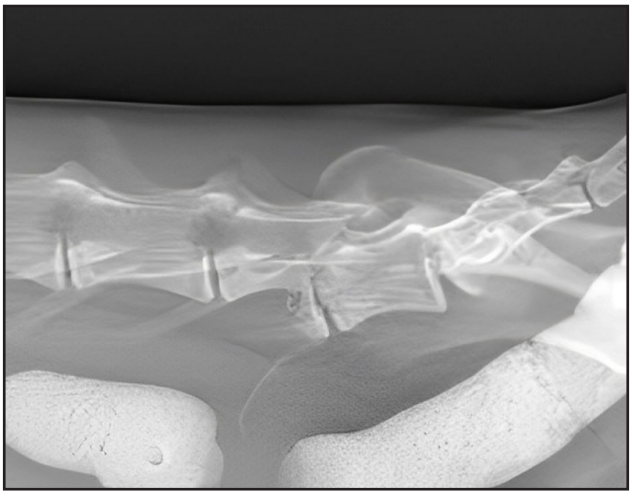

Figure 2. Radiological examinations revealed a fracture/dislocation in the vertebral body of L6 within the L6-L7 spinal cord segment L/L position. V/D position.

Figure 3. Examination of the 0.5 mm sagittal and transversal scans of the computed tomography revealed dislocation between L6-L7.

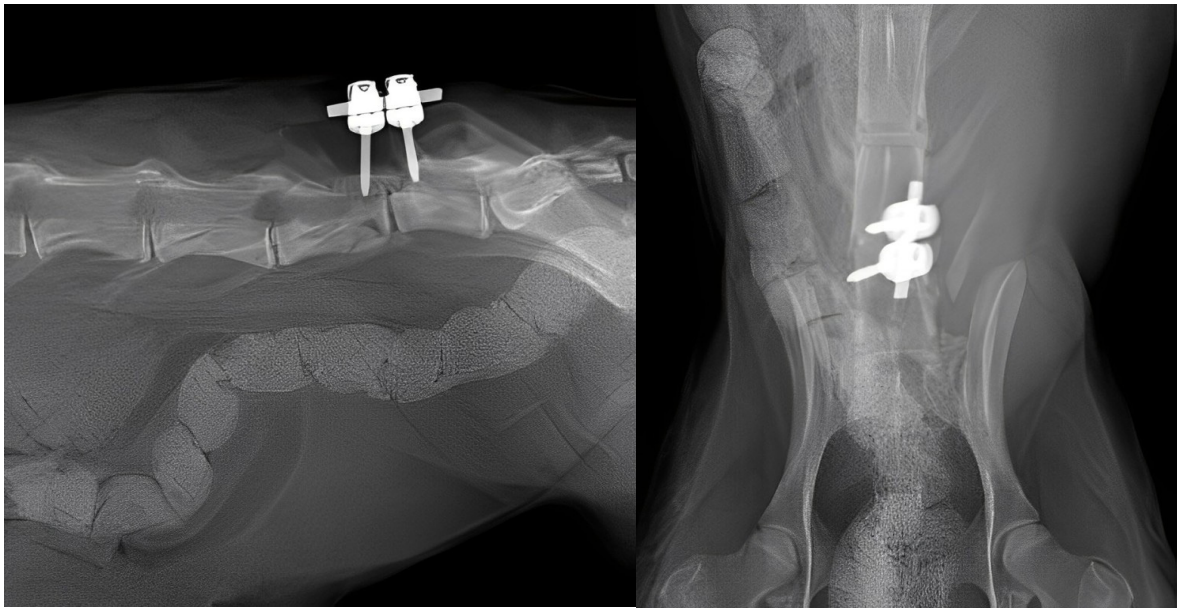

Figure 4. Postoperative radiological assessment demonstrated the mutual stabilization of L6-L7. A- L/L. B- V/D positions.

DISCUSSION

As this case marks the inaugural investigation into lumbar vertebral fractures in the fox, a comprehensive analysis was undertaken, drawing references from existing canine and feline literature. Lumbar vertebral fractures in dogs commonly result from traffic accidents and are typically characterized by a fracture in the caudal portion of the vertebral body. There is study on the use of polyaxial screws in lumbar instability in cats and dogs [4,10].

Due to the the fox's temperament, sedation was administered before radiography in the study. Cross-sectional imaging techniques, such as CT and magnetic resonans imagine (MRI), overcome many limitations of survey radiography. Their primary advantages include accuracy, multiplanar evaluation, and reduced need for extensive patient manipulation [8,12]. CT, in particular, can be considered the gold standard for assessing the osseous component of the vertebral column due to its high sensitivity (up to 100%) in detecting acute osseous lesions like spine fracture/luxation [3,5]. However, in our study, MRI was not conducted. Nevertheless, it was recommended that MRI could be employed if CT scan results indicated intramedullary or compressive spinal cord lesions, aiming for more precise prognostic factors.

Several techniques have been utilized for stabilizing sacrocaudal luxation in the thoracolumbar vertebrae of cats and dogs. Each technique has distinct advantages and disadvantages concerning invasiveness, ease of application, fixation stability, clinical outcomes, and applicability to various portions of the spinal column and patients of different sizes. These techniques encompass external immobilization, spinal stapling, spinous process plating, vertebral body plating, spinal process plating combined with the application of the Kirschner–Ehmer apparatus, composite fixation with pins or screws, PMMA implants, and stabilization with external fixators [6]. However, few studies have comprehensively evaluated the outcomes of specific techniques in a large number of animals [13]. Surgical intervention is often required for these fractures to alleviate severe pain. The most common surgical approach involves inserting a screw or pin into the vertebral body using a lateral approach [6,10]. However, in the L6 region, the Ala ossis ilium around L6 and L7 may pose challenges for lateral implantation. Meanwhile, a pilot study by Smolders *et al*. [16] suggested that Percutaneous Sacroiliac Facet Rod of the canine LS junction can serve as an adjunct to surgical decompression in dogs with LS disease and suspected LS joint instability. The results dem-

onstrated stability of the implants and improvement in hind limb function in Greyhounds with mild LS disease. Several studies have discussed various techniques to address the anatomical challenges, particularly in the context of L7 fractures [2,16]. The pedicle implantation method, specifically using the dorsal approach, has been highlighted as a preferable alternative to the lateral approach, especially for L7 fractures [16]. Notably, the literature is scarce in providing specific surgical management for complex fractures of the 6th lumbar vertebral body. Only a few case studies have been documented describing the repair of L6 fractures. Moreover, pedicle screw implantation for vertebral fracture treatment has been primarily described for L7, including fracture stabilization procedures [16]. Interestingly, implantation techniques have not been detailed for either L5 or L6 pedicles in dogs. In contrast to spinal injuries cranial to L6 in dogs, hindLimb motor function is typically preserved in L6 fractures, with reported neurological deficits including tail paresis and urinary/faecal incontinence. Loss of anal sphincter tone can result in perineal pain perception, and these conditions generally have a less favorable prognosis compared to spinal cord injuries. The current study noted a decrease but not a cessation of reflexes during clinical examination, suggesting intact motor function. Neurological deficits are less common in fractures beyond L6, especially in the absence of significant displacement on radiographs, as the cauda equina nerves exhibit greater tolerance [11]. However, L6 fractures can cause severe low back pain, hindering standing, and surgical stabilization is often indicated. In the observed case, a fracture of the corpus of L6 was identified. Neurological examination revealed decreased patellar, cranial tibial, sciatic, and anal reflexes, and computed tomography showed a dislocation between L6 and L7. Based on the literature review, although there are many techniques, but, a specific surgical technique for treating L6 fractures in dogs remains unclear. In treating vertebral fractures, most veterinary surgeons prefer a lateral approach with screw placement into the vertebral bodies and arthrodesis with plates or PMMA [6]. However, iliac wings can be used in combination with lateral implantation, as the L6-L7 anatomical environment is well-suited to this technique [14]. Ililectomy has also been described [15] but carries the risk of disability. Recently, the use of SOP plates has been applied to L7 fractures, requiring careful plate contouring. In this case, pedicle screw-rod fixation was employed, and good fixation was observed in the postoperative period. The biomechanical advantage of these dorsally applied fixation devices lies in their resistance to ventral bending forces associated with thoracolumbar sacrocaudal luxation since the implant is positioned on the tension side of the vertebral column, limiting flexion or extension.

As far as we are aware, this study represents the first documentation of traumatic spinal injuries in foxes. Due to the limited scientific literature on spine fractures/luxations in this species, our decisions were guided by medical guidelines for the closest domestic species. Introducing new data on foxes and similar species to the literature can be valuable for clinicians working with exotic animals. Additionally, the assessment of results from the application of pedicle screw-rod fixation, a procedure performed for the 1st time in a fox and similar species, would contribute to the existing knowledge in this field. The use of pedicle screw-rod application is considered to be straightforward, less invasive, and has shown favorable outcomes in the postoperative period. It has the potential to promote neurological and motor function recovery following surgery.

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Ethical approval. The study received approval from the Selçuk University Faculty of Veterinary Medicine Animal Experiments Local Ethics Committee, with the approval dated 2.12.2023 and numbered 646857.

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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