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First report on the diagnostic, treatment and recovery of a spinal fracture in a vulnerable Marbled Newt (*Triturus marmoratus,* Latreille, 1800)

Andreia Garcês[1,2,3*], Roberto Sargo[1,2,3], Camila Cardoso[1,3], Diogo Silva[1], Filipa Loureiro[1,2], Luís Sousa[1,3], Filipe Silva[1,2,3]

[1]*Wildlife Rehabilitation Centre (CRAS), Veterinary Teaching Hospital, University of Trás-os-Montes e Alto Douro (UTAD), Quinta dos Prados, 4500-801, Vila Real, Portugal.*
[2]*Animal and Veterinary Research Centre (CECAV), Associate Laboratory for Animal and Veterinary Sciences (AL4AnimalS), UTAD, Quinta dos Prados, 4500-801, Vila Real, Portugal.*
[3]*Department of Veterinary Sciences, School of Agrarian and Veterinary Sciences (ECAV), UTAD, Quinta dos Prados, 4500-801, Vila Real, Portugal.*

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*Correspondence:

Corresponding author: Andreia Garcês
E-mail address: andreiamvg@gmail.com

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ABSTRACT

A free-living adult female Marbled Newt (*Triturus marmoratus*), a species listed as Vulnerable by the IUCN, was admitted to the Wildlife Rehabilitation Centre of UTAD (CRAS-UTAD) with a spinal fracture and dorsal wound exposing the coelomic cavity. Clinical signs included hypoactivity, dyspnoea, and mild dehydration. Imaging confirmed a spinal fracture between the 8th and 9th vertebrae, with vertical dislocation and scoliosis, but without evidence of complete spinal cord severance. Treatment involved wound management, pharmacological therapy, and environmental support without spinal fixation. Despite wound complications and a prolonged recovery of 96 days, the animal retained full neurological function and mobility. It was successfully released into its natural habitat, having adapted to residual scoliosis and dermal thickening at the injury site. This case highlights the resilience and regenerative capacity of *T. marmoratus* and supports the feasibility of conservative management in selected cases of spinal trauma in amphibians.

Introduction

The Marbled Newt (*Triturus marmoratus,* Latreille, 1800) is a member of the family Salamandridae, native to the Iberian Peninsula and parts of western France. It is predominantly terrestrial, favouring mountainous and forested habitats with access to fresh water for breeding (Francillon-Vieillot *et al*., 1990). This amphibian species, typically measuring between 11 and 16 cm in length, is easily identifiable by its dark brown or black body adorned with irregular green markings. The ventral surface is black with off-white speckles (Francillon-Vieillot *et al*., 1990). Adult females characteristically display a distinctive orange stripe running longitudinally along the dorsum, from the head to the tip of the tail (Schoorl and Zuiderwijk, 1980; American Museum of Natural History, 2025). According to the IUCN Red List, *T. marmoratus* is classified as Vulnerable, primarily due to habitat loss, environmental pollution, and the introduction of invasive species and emerging infectious diseases (IUCN 2025).

Amphibians-particularly urodeles such as newts and salamanders-possess elongated bodies and relatively delicate vertebral columns, making them particularly susceptible to spinal trauma (Thygesen *et al*., 2019). Unlike mammals, the spinal cord in amphibians is less protected by the vertebrae, rendering it more vulnerable to mechanical injury (DiGeronimo and Brandão, 2019). Although spinal cord injuries in amphibians often result in neurological deficits, such as impaired locomotion or loss of sensory function, these species, especially urodeles, are notable for their exceptional regenerative capabilities (Thygesen *et al*., 2019). In some cases, they can regenerate spinal cord tissue, nerves, and even functional structures after severe trauma (Tanaka *et al*., 2013). Nonetheless, spinal injuries can cause significant morbidity, including partial or complete paralysis, cloacal dysfunction, and compromised survival in the wild (DiGeronimo and Brandão, 2019). The primary causes of spinal injuries in amphibians include blunt force trauma, often resulting from falls, predator attacks, or anthropogenic factors such as vehicular collisions or habitat disturbance. These injuries are rarely documented in clinical settings due to the small size of amphibians, their cryptic behaviours, and limited access to advanced imaging modalities, such as radiography and computed tomography (CT) scanning, in wildlife medicine (Urošević *et al*., 2016).

In this report, we described the clinical evaluation, diagnosis, and supportive treatment of a spinal fracture in a vulnerable Marbled Newt, contributing to the scarce literature on spinal trauma in free-living amphibians.

Case Report

On February 3, 2025, a free-living adult female Marbled Newt (*Triturus marmoratus,* Latreille, 1800) was admitted to the Wildlife Rehabilitation Centre of UTAD (CRAS-UTAD) for examination. The animal had been found the previous day while cleaning activities were underway in a garden.

Physical examination revealed that the newt was hypoactive, apathetic, and mildly dehydrated (approximately 6%). It exhibited dyspnoea, with periodic open-mouth breathing, and showed signs of pain when handled. A laceration (0.5 cm) was observed in the dorsal region, exposing the coelomic cavity. A spinal discontinuity was palpable approximately 1 cm caudal to the head. The animal became active when manipulated, and cloacal reflexes were present. It also showed sensitivity in the limbs and tail. The coelomic cavity was markedly distended. Reflexive movement of the left hind limb was slightly slower than that of the right.

Radiographic examination in both dorsoventral and laterolateral views, along with computed tomography (CT), was subsequently performed. The imaging revealed a spinal fracture approximately 1 cm caudal to the head, between the 8th and 9th vertebrae. In the lateral view, vertical dislocation of the 9th vertebra was observed, resulting in a pyramidal deformity of the spine (Figure 1). Based on the imaging, there did not appear to be a complete severance of the spinal cord. In the dorsal internal view, the spine had progressed from a symmetrical curvature to a scoliosis-like deformity.

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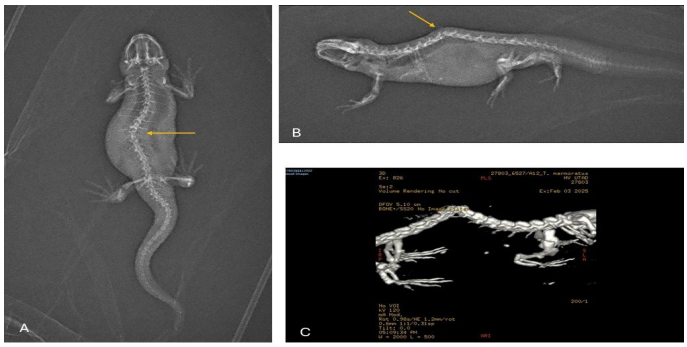

Figure 1. A - radiography imaging performed in dorsoventral view on the first day of admission showing a lateral dislocation to the left between 8-9th vertebrae (yellow arrow); B - Radiography imaging in the right laterolateral view performed on the first day of admission showing a vertical dislocation between 8-9th vertebrae (yellow arrow); C - Ventral (left) views of the 3D model obtained from CT.

The wound was cleaned and sutured, but no surgical fixation of the spinal lesion was performed. Treatment commenced with meloxicam (1 mg/kg, PO, SID) for 4 days, enrofloxacin (50 mg/kg, topical, SID) for 10 days, and a single dose of vitamin B1 (25 mg/kg, PO). The wound was cleaned daily with saline solution and treated with Omnimatrix© ointment (HiFarmaX Omnimatrix, Portugal). The animal was housed in an isolated aquatic setup with shallow water (depth <2 cm), a controlled temperature of 18–20°C, and UVB lighting provided for 6 hours per day. It was force-fed mealworms every other day to maintain nutritional support (Figure 2).

Figure 2. Progression of wound healing in a Marbled Newt (*Triturus marmoratus*) with a spinal fracture over 96 days of treatment.

By the 18th day of treatment, the wound over the spinal area remained open, and a colloid dressing was applied for the following 10 days. On the 48th day, an abscess developed at the wound site, requiring a second intervention to clean and re-suture the area. The initial treatment protocol, which included meloxicam, enrofloxacin, and daily wound care, was repeated. By day 64, the wound still had not completely closed (Figure 2). A final surgical procedure was performed to debride the wound edges and re-suture the site. At this stage, only meloxicam was administered as pharmaceutical support. Despite these complications, the animal retained full mobility throughout the recovery process, and no neurological deficits were observed (Figure 2). After 96 days of treatment, the animal was successfully released back into its natural habitat. Although a minor spinal deformity remained in the form of scoliosis, and the skin at the wound site had thickened, the newt had fully adapted to these changes.

Discussion

Spinal trauma in amphibians, particularly urodeles, is rarely documented, in part due to the small size of these animals, their cryptic behaviour, and limited access to diagnostic imaging in wildlife care settings (DiGeronimo and Brandão, 2019).

This case illustrates the potential for recovery from significant spinal trauma in amphibians, particularly urodeles (Thygesen *et al.*, 2019). The use of radiography and CT imaging in this case enabled an accurate diagnosis of a vertebral fracture with dislocation and scoliosis, guiding the treatment plan (Clayton and Gore, 2007). Urodele amphibians, such as newts and salamanders, are known for their exceptional ability to regenerate complex tissues, including limbs, tails, ocular tissue, cardiac muscle, and parts of the central nervous system (Tanaka and Ferretti, 2009). Following spinal cord injury, some species can regenerate neurons, and glial cells, and reestablish synaptic connections, restoring partial or full function. This capacity is mediated by the dedifferentiation of mature cells, proliferation of progenitor cells, and a permissive immune environment that promotes tissue reconstruction rather than scarring (Mchedlishvili *et al.*, 2007). In the context of vertebral injury, regeneration in urodeles extends beyond the spinal cord to include cartilage and bone tissue remodelling (Naguib, 2022), although the process may not restore original anatomical alignment, as seen in the residual scoliosis in this case. The observed wound healing and skin thickening further demonstrate the ability of amphibians to adapt morphologically to trauma, developing stable tissue over injury sites even in the absence of precise anatomical regeneration (Tanaka and Ferretti 2009). The absence of neurological deficits despite radiological evidence of spinal dislocation suggests that spinal cord continuity was preserved (Freitas *et al.*, 2019). The decision not to perform spinal fixation was based on the small size of the patient, anatomical constraints, and the regenerative potential of urodeles (Clayton and Gore, 2007). This aligns with existing literature that documents the remarkable capacity for spinal and neural tissue regeneration in some amphibian species, particularly in the family Salamandridae (Arenas Gómez *et al.*, 2017; Arenas Gómez and Echeverri, 2021).

Challenges during rehabilitation included delayed wound healing and abscess formation, which required repeated interventions (Chai, 2016). Also, in this particular animal Nutritional management was difficult since the animal refused to feed itself, making it necessary to force it almost daily, increasing its stress level. Wound management in amphibians is complicated by their permeable skin and susceptibility to infection (Poll, 2009). The combination of topical treatment, systemic anti-inflammatory and antimicrobial therapy, and strict environmental control played a key role in eventual wound closure (Naguib, 2022).

The newt retained full mobility throughout the 96-day rehabilitation period, with no signs of functional impairment, despite residual scoliosis and dermal thickening. Overall, this case contributes valuable clinical insight into the diagnosis and management of spinal injuries in amphibians and supports the potential for successful recovery through supportive care and monitoring in a controlled setting. This report adds to the limited but growing literature on the clinical management of spinal injuries in amphibians.

Conclusion

This case underscores the capacity for bone regeneration and neurological recovery in urodeles following vertebral trauma, especially when appropriately managed. CT imaging was invaluable for diagnosis and follow-up. This case contributes to the sparse literature on amphibian orthopaedics and supports the consideration of advanced diagnostics and pharmacotherapy in herpetological care. A wild Marbled Newt with a spinal fracture and dorsal wound was successfully rehabilitated over 96 days. Conservative management, including wound care, pharmacological treatment, and environmental support, resulted in full functional recovery and return to the wild. This case supports the viability of non-surgical approaches in managing spinal injuries in urodeles and underscores the importance of tailored rehabilitation protocols for vulnerable amphibian species.

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Conflict of interest

The authors have no conflict of interest to declare.

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