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Evaluation of radiological and computed tomographic findings of a mongrel dog with vertebral injury

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Abstract
A three-month-old Mongrel dog was presented to Veterinary Clinical Complex, Rajendranagar with a history of road traffic accident. The dog was in severe pain, lying in a lateral recumbent position, and was paraplegic. Neurological examination, survey radiography, and Computed Tomography (CT) were performed. The localized area for radiography was determined based on neurological evaluation. The dog was sedated with Inj. Xylazine and Inj. Butorphanol. Both lateral and ventrodorsal radiographs of the spine were taken, but they provided limited and indirect diagnostic details. On the other hand, CT evaluation revealed more comprehensive information about the spinal lesions. The stability of traumatic spinal injuries was assessed using the three-column spine principle. In conclusion, computed tomography proved to be a non-invasive and highly sensitive 3D imaging technique for diagnosing spinal injuries in dogs, surpassing the capabilities of conventional radiography.

Keywords: Computed tomography, dogs, radiography, fracture

Introduction
In small animal practice, most vertebral injuries often lead to various degrees of neurologic dysfunction, resulting in clinical signs like paresis and plegia. The thoracolumbar junction, situated between the relatively rigid thoracic and more flexible lumbar vertebrae, is the most common site for such injuries (Thanigaivel *et al*., 2017) [8]. Neurological examination and grading of spinal segment lesions were carried out following the protocols of Palus (2014) [5] and Denny and Butterworth (2000) [3], respectively. Initially, survey radiography and myelography serve as the primary and most commonly used methods for diagnosing spinal diseases in veterinary practice.
However, in human medicine, computed tomography (CT) has gained widespread recognition as the central diagnostic imaging modality for neurological, oncological, and orthopaedic cases (Kinns *et al*., 2006) [4]. In India, CT is now emerging as a crucial diagnostic tool, especially in orthopaedic cases involving animals. CT offers several advantages over conventional radiographs, as it provides images without the effects of superimposition and offers superior soft tissue differentiation (contrast resolution). Furthermore, its spatial resolution is far superior, as demonstrated by Serra *et al*. (2021) [7]. This emphasizes the need to extend the application of CT in veterinary medicine, particularly for enhancing the diagnosis of spinal injuries.

Case History and Observations
A three-month-old Mongrel weighing 2.5 kg was presented to the outpatient unit of the Surgery department at the Veterinary Clinical Complex, C.V.Sc, Rajendranagar, PVNRTVU. The dog had a history of a road traffic accident and exhibited severe pain, lateral recumbency, and paraplegia. The dog showed signs of upper motor neuron (UMN) deficit, with lesions observed in the T3 to L3 segment. It displayed paraplegia along with urinary retention and overflow, accompanied by a loss of conscious pain sensation (CPS), graded as grade 6. There was no history of deworming or vaccination, as it was a rescued dog. To facilitate radiographic and computed tomographic examination, the dog was sedated with Inj. Xylazine at a dose rate of 1mg/kg body weight intramuscularly and Inj. Butorphanol at a dose rate of 0.2 mg/kg body weight intramuscularly.

Radiographic and computed tomographic examination

Upon examination, the thoracolumbar spinal radiograph showed a caudal physical fracture of the L1 vertebrae (Figure 1). The sagittal plane analysis revealed a fracture of the L1 vertebral body with luxation of the caudal part to the L1 vertebrae (Figure 2). Further evaluation through CT axial plane imaging uncovered a fracture fragment that had become displaced in the vertebral canal. The bony HU index was measured at 507 ± 246 HU, indicating the presence of a bony fragment within the vertebral canal, which was exerting compression on the spinal cord (Figure 3 and 4). Given that the fracture involved more than two compartments, it was deemed unstable Kinns *et al*. (2006) [4] and Ricciardi (2016) [6] (Figure 5).

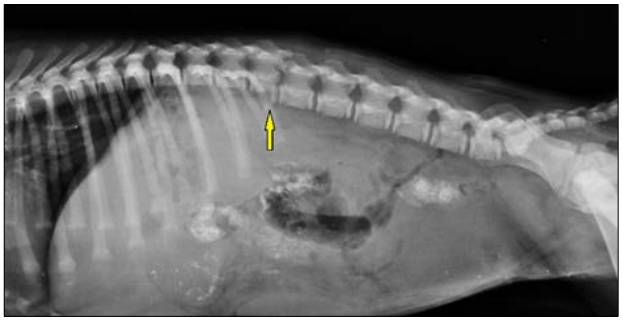

Fig 1: Lateral radiograph showing caudal physeal fracture of L1 vertebrae.

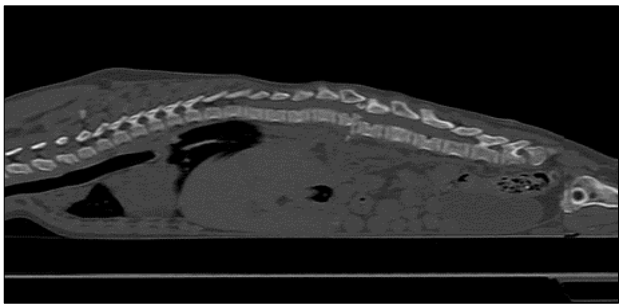

Fig 2: Sagittal plane of CT showingfracture of L1 vertebral body with luxation of caudal part to the L1 vertebrae.

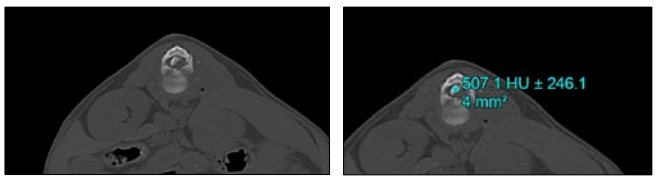

Fig 3 and 4: Axial plane showing displacement of fracture fragments in vertebral canal

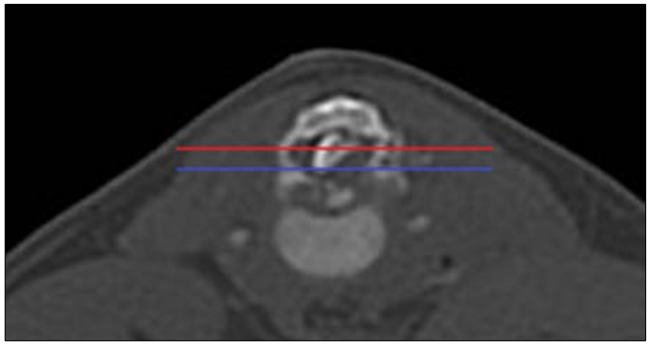

Fig 5: Axial plane showing fracture in all three compartments considered as unstable fracture

Fig 6: 3D image showing fracture at the level of L1

Discussion and Conclusion

In the current case, we observed paraplegia and gait abnormalities, which are consistent with the findings of Palus (2014) [5]. Palus noted that the location of the injury in the upper and lower motor neurons can lead to various types of paresis. The grading of spinal lesions can be correlated with gait abnormalities and the results of spinal reflex examinations, aligning with the observations of Denny and Butterworth (2000) [3]. The type of vertebral fracture can vary from one animal to another, depending on factors such as the position of the animal, the type of force exerted during trauma, and the inherent strengths and weaknesses of the vertebral column. This is in accordance with studies by Bagley (2000) [1], Kinns *et al*. (2006) [4], and Bruce *et al*. (2008) [2], which found a higher incidence of fractures and luxation's in dogs.

In the present case, we observed fractures in all three compartments, and we assessed the stability of the fracture using the three-column spine principle. The vertebral column was divided into three compartments: the dorsal compartment, which includes the spinous process, vertebral laminae, articular processes, vertebral pedicles, and dorsal ligamentous complex; the middle compartment, which includes the dorsal longitudinal ligament, dorsal annulus fibrosis, and dorsal vertebral body; and the ventral compartment, which includes the remaining vertebral body, lateral and ventral aspects of the annulus fibrosus, the nucleus pulposus, and the ventral longitudinal ligament. Regardless of the degree of displacement, fractures involving two or more components were considered unstable and suggested for surgical stabilization, consistent with the findings of Kinns *et al*. (2006) [4] and Ricciardi (2016) [6].

Survey radiographs provided anatomical landmarks for major lesions but offered limited and indirect diagnostic details about the spinal injuries. The 2D nature of radiographs, along with superimposition by unrelated structures, made it challenging to visualize minute details. In contrast, CT, with its superior contrast resolution and tomographic nature, overcame the problem of superimposition typically seen in traditional radiographs. Thus, CT proved ideal for characterizing and localizing traumatic bone lesions, particularly complex structures like vertebrae. Additionally, understanding the position of fragments in relation to the spinal canal was extremely useful for surgical planning, management, and predicting the patient's prognosis.

The critical factor in determining whether conservative or surgical therapy is most appropriate hinges on the issue of instability. The application of the three-column spine principle played a crucial role in assessing the stability of the fracture.

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