RESEARCH ARTICLE

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Retrospective Evaluation of Spinal Trauma Treatments in 58 Cats and 12 Dogs

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Abstract

Traumatic vertebral fractures and/or dislocations in cats and dogs can cause severe spinal cord injury, resulting in severe conditions such as pain, urinary incontinence, paresis or paraplegia. This study involved 58 cats and 12 dogs with external spinal trauma, and it was aimed to present the etiology, treatment and results, retrospectively. After the location of the neurological damage was determined, the patients were treated either conservatively or surgically. One of the surgical methods such as polyaxial screw, locking plate application and external fixation application was decided. In the treated animals, complete recovery was seen in 10 cats and functional recovery in 14 cats and 1 dog, but 12 cats and 2 dogs were in poor condition. Loss of deep pain sensation after spinal trauma is important for prognosis. Although there are many different treatment options, the decision should be made according to the patient's condition and the surgeon's preference. In addition, patients with spinal trauma also require serious trauma management and it is very important that the animal's vital values are stable.

Keywords: Spinal trauma, vertebral surgery, polyaxial screw, locking plate, cat, dog.

INTRODUCTION

In small animal practice, neurological spinal cord diseases such as intervertebral disc disease are not always caused by trauma. However, vertebral fractures and dislocations can cause serious spinal cord injury. This is about 10% of all neurological problems in dogs and cats (Orgonikova et al., 2021). In cats and dogs, traffic accidents, falling from a height and gunshot wounds are among the main causes of spinal trauma (Grasmueck and Steffen, 2004; Bruce et al., 2008; Bali et al., 2009; Ahn et al., 2015; Özak et al., 2018; Diamante et al., 2020; Orgonikova et al., 2021; Caterino et al., 2022). The most common spinal injuries are seen in the lumbar vertebrae, followed by the sacrococcygeal, thoracic and cervical vertebrae. Also, a high incidence of fractures or luxation at the thoracolumbar and lumbosacral junctions has been reported (Bruce et al., 2008; Diamante et al., 2020). Spinal cord injuries can cause serious conditions ranging from localized pain to paresis, paraplegia or tetraplegia (Kirby 2010; Negrin and Cherubini 2016; Inglez et al., 2017).

It is recommended to approach a patient with spinal trauma in three steps (Sulla et al., 2019; Orgonikova et al., 2021). These;

Step 1: Airways-breathing-circulation (ABC) assessment, stabilization and immobilization
Step 2: Neurological examination
Step 3: Analgesia, sedation, or anxiolysis.

Treatment depends on the patient's signal, the nature of the injury, the neurological status, and the individual surgeon's experience (Bruce et al., 2008). Treatment is generally considered conservative and surgical. Conservative treatment typically consists of splints and bandages, cage confinement, exercise restriction, and administration of steroids. In surgical treatment, decompression of the spinal cord and rigid stabilization of the spinal canal are aimed. For this purpose, various fastening systems such as pins and polymethylmethacrylate (PMMA), screws and plates are used (Bruce et al., 2008; Kirby, 2010; Özak et al., 2018; Sulla et al., 2019). Because of the poor prognosis and persistent suffering of the severely affected animal, many owners consider euthanasia (Sulla et al., 2019).

In this study, it was aimed to present the etiology, treatment and results retrospectively in cats and dogs with spinal trauma.

MATERIALS AND METHODS

This study was carried out in Dicle University Veterinary Faculty surgery clinics between 2019 and 2022. 58 cats and 12 dogs with spinal trauma were included in the study and analyzed, retrospectively. The case inclusion was accepted based on clinical and neurological records, radiographic data and treatment information. The neurological diagnosis was based on clinical, neurological, radiographic examination and intraoperative findings. The data obtained from the records were focused on the etiology, neurological and radiographic findings and treatment (non-surgical/surgical). While surgical treatment included dorsal laminectomy and hemilaminectomy for decompression, it consisted of the use of a polyaxial screw, locking plate and external fixator for vertebral stabilization. After the treatment, it was

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followed up with phone calls and repeated neurological examinations on a weekly basis. For at least four weeks, a visible improvement was observed. There were cases with a follow-up period of four weeks to two years. At the end of the study, cases were clinically classified as complete, functional, or poor (as in the previously reported studies, Grasmueck and Steffen, 2004).

In addition to the age, sex and breed information of cats and dogs, the localization of a detected condition such as vertebral fracture, luxation, or compression was recorded. Common causes included trauma information such as traffic accidents, falls from height, other animal attacks, and gunshot wounds. It was also clinically graded into five groups according to the severity of their neurological dysfunction as Grasmueck and Steffen, (2004) (Table 1).

Table 1. Grades according to the severity of neurological symptoms as Grasmueck and Steffen, (2004).

Grade I	Back pain, no neurological deficits	5 cats, 1 dog
Grade II	Ambulatory paraparesis, normal micturition	7 cats
Grade III	Ambulatory paraparesis, urinary retention	14 cats, 3 dogs
Grade IV	Non-ambulatory paraparesis/paraplegia, urinary retention, intact deep pain perception	15 cats,
Grade V	Paraplegia, urinary retention, loss of deep pain perception	17 cats, 8 dogs

In order to evaluate the perception of deep pain, the extremities and tail were clamped with forceps, while the head region of the animal, especially the eyes, was followed well. Deep pain perception of cats with suspicious responses to the stimulus was considered negative.

Radiographs were taken in latero-lateral and ventro-dorsal positions in all cases. In suspicious cases, myelography was performed by entering the subarachnoid space with cisternal or lumbar puncture under general anesthesia. For myelography, iohexol 0.3 ml/kg body weight (Omnipaque^{TM} 350; Opakim-İstanbul) was injected via a 20-22 G spinal needle.

In terms of the treatment group, the patients are categorized as conservative and surgical. Conservative treatment consisted of cage rest and exercise restriction. Surgical techniques were polyaxial screwing, locking plates and external fixator, which are among the stabilization techniques (Figure 1-3). Dorsal laminectomy or hemilaminectomy was also performed for decompression (Table 2). Treatment groups were not randomized and treatment decisions were made based on clinical judgment, clinician preference, as well as owner financial status.

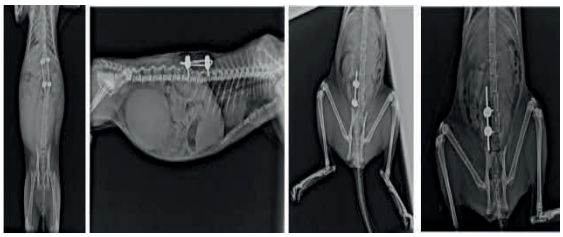

Figure 1. Examples of cases using polyaxial screwing; The first two images on the left belong to the same case, the rod used to fix the polyaxial screws was used reciprocally, while in the cases in the other two images, one-sided rods were used.

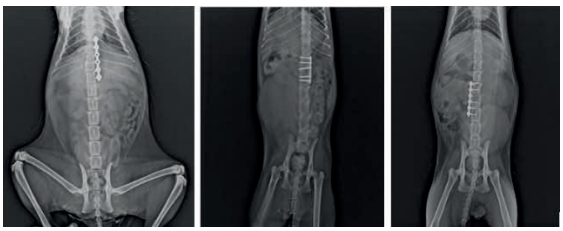

Figure 2. A few examples of cases where SOP plates were used for vertebral stabilization; It is more beneficial to provide stabilization with one anterior and one posterior vertebra, especially in end-plate fractures.

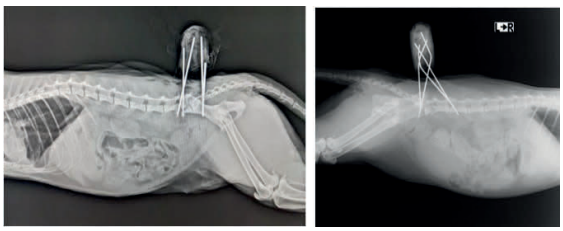

Figure 3. The use of external fixators for vertebral stabilization is not very common for this subject, but can be particularly useful for caudal vertebrae.

Table 2. Localization of trauma and planned treatment in cases.

Animals	**Gender**	**Localization**					**Treatment group**					
							Non-surgical	**Surgical**				
								For decompression		For stabilization		
		C1-C5	C6-T2	T3-L3	L4-L7	S1-S3		DL	HL	PS	LP	EF
Cats	37 F	-	2	16	18	1	4	13	5	12	8	4
(n=58)	21 M	-	-	11	10	-	1	9	2	6	4	2
Dogs	4 F	1	1	2	-	-	4	-	-	-	-	-
(n=12)	8 M	-	-	2	6	1	1	3	-	1	2	-

DL: Dorsal laminectomy, HL: Hemilaminectomy, PS: Polyaxial screwing, LP: Locking plates, EF: External fixator. - During the operation, decompression was achieved first, followed by vertebral stabilization.

Among the patients who were planned for surgery, autologous plasma-rich platelets (PRP) were applied to the spinal cord during the operation in those who underwent dorsal laminectomy or hemilaminectomy. After deciding whether all blood samples were suitable for platelet, white blood cell (WBC) and hematocrit (Hct) analysis according to the hematology laboratory results, PRP was prepared by double centrifugation technique as previously reported (Arican et al., 2018).

Most of the cases (50 cats-86%, 10 dogs 83%) could be followed up after treatment to evaluate clinical outcomes. Persistent difficulty in urination and/or lack of improvement in walking after treatment was defined as a poor outcome. Bladder control and the ability to walk unaided and painless were considered functional improvement. Complete recovery was normal urination, normal gait and absence of proprioceptive abnormalities.

RESULTS

All patients (58 cats and 12 dogs) had varying degrees of neurological dysfunction. This neurological dysfunction distribution was determined as 5 cats and 1 dog in grade I, 7 cats in grade II, 14 cats 3 dogs in grade III, and 15 cats in grade IV, and 17 cats and 8 dogs in grade V (Table 1). Urinary retention was observed in 46 cats (79%) and 11 dogs (91%).

In terms of the affected area, respectively, L4-L7 (28 cats-48%, 6 dogs-54%), T3-L3 (27 cats 46%, 4 dogs-36%), C6-T2 (2 cats-3%, 1 dog- 1%), S1-S3 (1 cat-1%, 1 dog-1%) (Table 2).

In cats with grade II and III neurological dysfunction (n=21), the outcome was poor in five, functional recovery in nine, and complete recovery in seven. In dogs with grade III neurologic dysfunction (n=3), two had poor results and one had functional improvement. In cats with grade IV neurological dysfunction (n=15), recovery was weak in seven, functional in five, and complete in three. In all cats (n=17) and dogs (n=8) classified as having grade V neurological dysfunction, no treatment was applied by consensus of the owner.

Of the five cats treated non-surgically, three recovered completely, one functionally recovered and one had poor outcomes. While 1 out of 5 dogs fully recovered, 1 recovered functionally, and there was no news from the others (3 dogs). In this group, animals were treated only with cage rest and rehabilitation treatment without the use of steroids.

According to the data in the study, in terms of trauma; there were 49 falls from height, 7 traffic accidents and 2 unknown cases in cats. The cause of spinal trauma in dogs was a traffic accident in six, while the cause of the other six was unknown.

DISCUSSION AND CONCLUSION

Traumatic spinal cord injuries in cats and dogs are still an important issue. Although medical and/or surgical treatment protocols have been defined in the literature, clinical data are limited. In addition, it is reported that paraplegic cases with spontaneous herniation of degenerated discs or spinal cord injury in traumatic situations have a good prognosis provided that timely decompression is performed (Grasmueck and Steffen, 2004; Bali et al., 2009). Therefore, in this clinical study conducted on 58 cats and 12 dogs, it was aimed to retrospectively report the clinical results of spinal trauma patient management and treatments to veterinary practice.

Mostly, traffic accidents, falls from height, gunshot wounds and other animal attacks are among the causes of spinal trauma (Grasmueck and Steffen, 2004; Bruce et al., 2008; Bali et al., 2009; Ahn et al., 2015; Gönenci et al., 2017; Özak et al., 2018; Diamante et al., 2020; Orgonikova et al., 2021; Caterino et al., 2022). In our study, it was observed that falling from a height (84%) and traffic accidents (12%) were effective in cats in general, and traffic accidents (50%) were effective in dogs. Vertebral fracture or luxation depends on the severity of the trauma forces. However, in this study, neither cats nor dogs found a remarkable association with the cause of the trauma in terms of severity of the injury, location of the lesion, presence of multiple lesions, or incidence of complications.

Vertebral fracture or luxation usually occurs in the vertebrae (corpus or end plate) or in the joint between the vertebrae, close to the skull, thorax, and pelvis. The terminal thoracic region is the most commonly affected area in the dog. Most of the lesions in the thoracolumbar region were reported with similar results in dogs (58%) and cats (49%). It has been reported that the closest region to this is the lumbar region (L1-L7) and then the sacro-caudal region (S1-Cc3) (Bali et al., 2009; Grasmueck and Steffen 2004). In our study, the rate of injury at L4-L7 (28 cats-48%) and T3-L3 (27 cats 46%) levels were found to be very close to each other. This was followed by C6-T2 (2 cats-36) and S1-S3 (1 cat-1%). Although the number of cases was limited in dogs, similar results were found as in cats (L4-L7; 6 dogs-54%, T3-L3; 4 dogs-36%), C6-T2; 1 dog- 1%, S1-S3; 1 dog-1%).

Animals with spinal trauma and vertebral fracture or luxation may have spinal discomfort, paresis or paralysis, depending on the location and severity of the injury. These are similar to those in patients with other spinal cord lesions such as intervertebral disc disease and fibrocartilaginous embolism (Orgonikova et al., 2021). A rapid scan is initially sufficient to evaluate an animal with a spinal fracture or luxation. A complete neurologic examination may not initially be necessary to avoid possible iatrogenic damage to the patient's manipulation during the postural reaction test. The neurological examination aims to localize the lesion(s) affecting the nervous system and determine its extent and severity. Initial grading is the most important clinical feature that affects the prognosis or treatment outcome of a spinal cord injury (Grasmueck and Steffen 2004; Orgonikova et al., 2021).

In patients with spinal trauma, the presence of deep pain sensation following spinal trauma is one of the most important findings for prognosis. Because lack of perception of deep pain associated with luxation and fractured vertebra means a poor prognosis. In addition, urinary and/or fecal incontinence, perineal reflex, deep pain sensation in genital, anal and tail should be evaluated in spinal traumas (Negrin and Cherubini, 2016). A second spinal injury has been reported in approximately 20% of patients with thoracolumbar fractures (Grasmueck and Steffen, 2004); therefore, CT or MRI imaging of all vertebrae should be performed in spinal traumas (Negrin and Cherubini, 2016). In our study, a detailed neurological examination was performed in all animals, and urinary or fecal incontinence was examined as well as deep pain sensation. Urinary incontinence was seen in 77% of cats (n=45) and 91% of dogs (n=11). Deep pain sensation loss was seen in 17 cats (29%) and 8 dogs (66%). It is obvious

that a paraplegic animal does not have a comfortable life. In addition, it is very difficult to care for an animal with urinary incontinence at home, and patient owners often have difficulties. On the other hand, CT could not be used in our study because we did not have such an opportunity. However, myelography was performed alongside direct radiography. In addition, we did not do epidurography, but epidurography could have been done for a similar purpose.

Systemic stabilization is important in the management of a patient with spinal trauma, and evaluation of the airway, respiration and circulation is essential (Eminaga et al., 2011). HCT, total protein level, urea and creatinine concentration, and electrolyte balance should be checked as soon as possible. Fluid therapy is important to maintain spinal cord perfusion, depending on the severity of hypotension, isotonic crystalloids, hypertonic saline, colloids, or blood products can be used (Eminaga et al., 2011; Negrin and Cherubini, 2016). As in all trauma patients, the "airways-breathing-circulation (ABC)" evaluation in spinal trauma patients should be considered by the trauma protocol, and this was also done in our study. If the patient was stable, a detailed neurological examination was subsequently performed.

Another topic of discussion is the use of steroids in acute spinal trauma. Because it can cause secondary side effects, including infection and gastrointestinal symptoms (Grasmueck and Steffen, 2004; Negrin and Cherubini, 2016). Steroid administration was not used in our study.

Platelet-rich plasma (PRP) is a concentrated source of autologous platelets in plasma. Since PRP contains autologous growth factors that accelerate tissue healing, it is known to be used in different areas such as wound healing, peripheral nerve injuries, and after plastic surgery. In addition, there are animal studies on its applications in the spinal cord (Chen et al., 2018). In our study, PRP was prepared and applied locally on the spinal cord in the form of drops in all of the cases who underwent laminectomy. This study was not conducted to directly evaluate the efficacy of PRP on spinal cord damage/healing, but we think that PRP application will also be beneficial if blood values are appropriate and spinal cord decompression will be performed.

Although many different techniques are used for stabilization in vertebral fractures or luxations, some of the applications that find common use among these are the use of polyaxial screws, stabilization with polymethylmethacrylate (PMMA) and plate applications (Grasmueck and Steffen, 2004; Negrin and Cherubini, 2016; Özak et al., 2018; Diamante et al., 2020; Orgonikova et al., 2021). In our study, fixation with polyaxial screwing (18 cats, 1 dog), locking plate (nearly all of them consisted of String of Pearls plate, SOP plate) (12 cats, 2 dogs) and external fixator (6 cats) techniques were used. Which of these methods will be used is completely determined by the patient's condition and the surgeon's decision. It is difficult to say which of the techniques is more effective according to the fracture structure. They are methods that really give results when applied well. We did not encounter any complications arising from any preferred method itself. In addition, dorsal laminectomy or hemilaminectomy techniques have been described for decompression of the vertebral column, and decompression is required (Özak et al., 2018; Orgonikova et al., 2021). In our study, an electro-power device with a diamond milling tip was used to open the lamina during laminectomies. Afterward, he worked with kerrison rongeur measuring 0.8 mm for cats and 1.2 mm for dogs. We recommend using a kerrison rongeur instead of forceps such as rongeur to work in favor of the spinal cord during laminectomy.

In paraplegic cats, the intact sense of deep pain is very important in terms of neurological damage and treatment prognosis. The spinal trauma patient is also a trauma patient. It requires trauma management and it is very important that the vital organs of the animal are stable. Subsequently requires a good neurological examination and needs to make a good treatment decision. There are different stabilization methods preferred for treatment, and this is entirely dependent on the surgeon's choice, set inventory, and patient's condition. Even if there is no complete clinical recovery, animals with functional recovery can continue their lives more comfortably at home.

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Conflict of Interest
The authors declare that they have no competing interests.

Authorship contributions
Concept: S.Y., Design: S.Y., S.A., Data Collection or Processing: N.S., M.K., Analysis or Interpretation: E.Ç., Literature Search: B.E.K., Writing: S.Y.

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Ethical Approval
All methods and procedures used in this study comply with the guidelines of the Turkey and EU directive (Directive 2010/63/EU) on the protection of animals used for scientific purposes. This study did not require approval from the authorities or the ethics committee of the institution. However, patient owners were informed and consent was obtained.

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