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Evaluation of vertebral endplate fractures associated with spinal trauma in cats: Short-term clinical outcomes*

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Summary

This retrospective study analyzed 79 cats with spinal trauma treated at Dicle University Faculty of Veterinary Medicine between 2022 and 2025, focusing on 12 cases (9.48%) with radiographically confirmed vertebral endplate fractures. Cases were graded I-V based on neurological dysfunction, which guided surgical planning. Fractures were observed at various levels in the thoracolumbar region and often extended beyond the endplate to dorsal or middle vertebral segments. Surgical stabilization was performed using a polyaxial screw and rod system; some cases also required hemilaminectomy or laminectomy. Postoperative follow-up over four weeks showed that recovery was good in 25% (3/12) of cases, functional in 33% (4/12) of cases, and poor in 25% (3/12) of cases. In 17% (2/12) of cases treatment was declined. Fractures in the thoracic region were associated with worse outcomes compared to lumbar fractures. Additionally, postoperative passive exercises and physical therapy appeared to support recovery. The findings emphasize that vertebral endplate fractures, although frequently overlooked, are crucial for maintaining spinal stability and disc health. Accurate early diagnosis, combined with anatomical reduction and appropriate stabilization techniques, is vital for long-term success, especially in young animals. The study highlights the need for clinicians to prioritize endplate fractures during diagnosis and surgical intervention, as proper management can significantly improve long-term neurological and structural outcomes in feline spinal trauma.

Keywords: cat vertebral endplate fractures, polyaxial screw, spinal trauma, short-term clinical outcomes, vertebral stabilization

Although some neurological conditions in small animal practice, such as intervertebral disc disease (IVDD), spondylitis, discospondylitis, and spinal tumors, are not always caused by trauma, severe spinal cord injuries, such as vertebral fractures and dislocations, are typically the result of spinal trauma. Spinal trauma accounts for approximately 10% of all neurological issues in dogs and cats (16, 22). As in many other animal species, the primary cause of spinal trauma in cats are often traffic accidents, with high-energy traumas, such as high-rise syndrome and gunshot injuries being among the main etiologies (20).

Fractures or dislocations resulting from spinal trauma affecting regions such as the atlanto-occipital, atlantoaxial, cervicothoracic, and thoracolumbar areas will naturally impact the intervertebral joints and their supporting structures. These joints and supporting tissues – including the articular process joints, articular cartilage, synovial membrane, capsule, synovial fluid, intervertebral discs, and ligaments – are more susceptible to movements such as flexion-extension, torsion, and axial loading (10). This force can lead to instability in addition to fractures and dislocations of vertebrae. To evaluate the severity of vertebral fractures and dislocations as well as the resulting instability, a three-segmental approach has been proposed, dividing the vertebrae into dorsal, middle, and ventral regions

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(4, 11, 12, 14, 19, 21). The dorsal segment includes the vertebral arch, articular processes, and supporting ligaments. The middle segment consists of the spinal cord, dorsal longitudinal ligament, annulus fibrosus, and the dorsal edge of the body. The ventral segment comprises the remaining part of the vertebral body, the annulus, and the ventral longitudinal ligament. According to this classification, the endplate is located on the ventral side of the vertebra, but endplate fractures often involve both the ventral and mid-segments of the vertebra. If multiple segments are affected, surgical stabilization should be performed to ensure stability. For this purpose, various methods have been described, including polyaxial screws, the „string of pearls" (SOP) plate, and fixation with many different plates, pins, and polymethylmethacrylate (PMMA), as well as the use of external fixators (3, 5, 13, 17, 20). However, none of these methods are dedicated specifically to the treatment of endplate fractures; rather, they are primarily aimed at stabilizing the vertebral column.

The significance of endplate fractures is often overlooked among vertebral fractures. However, the endplate is critically important for vertebral health in cats, just as it is in humans and other animals. As it is in relation with the intervertebral disc, the endplate plays a vital role in nutrient diffusion to the disc. Moreover, issues involving the endplate, which functions as the growth plate of the vertebra, can prevent the vertebra from developing properly. Therefore, the endplate has both mechanical and metabolic roles in maintaining vertebral health. Consequently, when the endplate is affected in cases of spinal trauma, it is essential to restore it to its normal structure (15, 18).

This study aimed to determine the prevalence of endplate fractures among vertebral trauma cases in cats, describe their clinical and radiographic characteristics, and report the postoperative outcomes at a 4-week follow-up after surgical stabilization with polyaxial screw-rod fixation.

Material and methods

Animal material. This study retrospectively analyzed 12 cats diagnosed with endplate issues among a total of 79 cats presented with vertebral fractures, dislocations, or stabilization related to spinal trauma at the Surgery Clinics of Dicle University Faculty of Veterinary Medicine between 2022 and 2025. The study included cats with a history of spinal trauma that had been diagnosed with endplate fractures. Selection of cats for the study was not based on their breed, sex, or age. In addition, cats with concurrent trauma affecting other body regions were not excluded from the study – the purpose was to evaluate potential associations between endplate fractures and other concomitant conditions, including long bone fractures, pneumothorax, effusion, and other traumatic injuries. Detailed clinical and neurological examination records, radiographic data, and treatment information for each case were collected. Neurological diagnosis was based on clinical, neurological, and radiographic examinations, as well as intraoperative findings.

Trauma management. In our surgical clinic, spinal trauma patients were routinely managed using a three-step approach, as previously recommended by other researchers (16, 19, 20) These steps included (step 1) assessment of the airway, breathing, and circulation (ABC), followed by stabilization and immobilization, (step 2) neurological examination, and (step 3) analgesia, sedation, or anxiolysis. Additionally, the severity of neurological dysfunction was graded on a scale of 1 to 5 reported by Grasmueck and Steffen (2004) (9).

Clinical examination. During neurological examination, deep pain perception was assessed by pinching the limbs and tail with forceps, while closely monitoring the animal's head region, especially the eyes. Cats exhibiting questionable responses to stimulation were considered to have a negative deep pain perception.

Radiographs were obtained in all cases in both lateral (L/L) and ventrodorsal (V/D) views. The structure of the vertebrae, vertebral stabilization, intervertebral space, and the distance between the endplate and the vertebral body were evaluated in radiographs. In addition to recording the age, sex, and breed of the patients, data were also collected regarding the presence of fractures in other regions of the vertebrae alongside the endplate fracture, as well as any fractures in other bones.

Anesthesia and surgical plan. In each case, surgeries were performed after induction with an injection of medetomidine at a dose of 80 μg/kg IM (Domitor®, Orion Pharma, Finland), butorphanol at 0.4 mg/kg SC (Butomidor® 10 mg/mL, Richter-Pharma, Austria), and ketamine at 5 mg/kg IM (Ketasol®, Richer-Pharma, Austria). Following induction, the animals were intubated and maintained under anesthesia with isoflurane (1.5-2.5%) (Isoflurane 100 mL, Adeka İlaç, Türkiye). For postoperative analgesia, a mixture containing 12 mg ketamine, 4.8 mg butorphanol, and 40 mcg medetomidine was diluted in 100 mL of 0.9% isotonic sodium chloride solution and administered via intravenous infusion at a rate of 5 mL/kg/hour using an automatic infusion pump throughout the perioperative period and the surgery (5). In addition, before starting all operations, antibiotic prophylaxis was started preemptively with Cefazolin sodium intravenously (IV) at a dose of 20-22 mg/kg (Cezol, Deva, Türkiye) and continued throughout the operation.

Following general anesthesia, the cats were placed in sternal recumbency. Access to the spine was gained through a dorsal incision as recommended by the authors (5, 17), and at least two vertebrae cranial and caudal to the lesion were laterally exposed. The dorsal fascia was carefully incised bilaterally on both sides of the spinous processes located at the center of the lesion. To preserve the stability of the vertebral column, the supraspinous and interspinous ligaments between the spinous processes were maintained.

The epaxial muscles were dissected from the spinous processes, articular processes, and pedicles to access the transverse processes. When compression in the vertebral canal was suspected based on radiographic findings, dorsal laminectomy was performed for decompression. The laminectomy procedure was carried out using an electropaver device (BSP-M200 High Speed Electrical Saw Drill BlueSAO®) equipped with a diamond burr, followed by the use of a 0.8 mm Kerrison rongeur. For the lumbar vertebrae, the transverse processes were used as fixation points, whereas for thoracic vertebrae, the vertebrocostal articulations were selected for the placement of polyaxial screws. The screws (1.8 or 2.0 mm, depending on the size of the cat) were inserted perpendicular to the pre-drilled canal with an appropriate diameter for each patient. After screw placement, a rod was introduced to connect the screws and complete the stabilization. Once the stabilization was secured, the surgical site was routinely closed. Additionally, the animals were non-invasively monitored throughout the perioperative period with a veterinary monitor device (Veterinary Monitor Device: YSD 16V-vet). Postoperatively, antibiotic therapy was administered for 5 days, consisting of amoxicillin-clavulanic acid at a dose of 12.5 mg/kg IM, and analgesia was maintained with subcutaneous meloxicam at 0.2 mg/kg for 3 days. Antibiotic duration was extended in cases at risk of infection during clinical follow-up.

Postoperative follow-up. The cases were followed for at least four weeks through telephone consultations and weekly neurological examinations.

Throughout the postoperative period (the same day every week), the cases were clinically classified as good, functional, or poor according to a grading system described by Grasmueck and Steffen (2004) (9). In this classification, persistent difficulty with urination and lack of improvement in walking after treatment were considered poor outcomes. The ability to urinate normally, walk independently without assistance, and remain free of pain were regarded as indicators of functional recovery. Complete recovery was defined as the absence of urinary issues, normal gait, and no proprioceptive deficits.

Statistical analysis. Statistical calculations were performed on the data obtained from the study using the Minitap 18 package program. Due to the small sample size (n = 12), all data were evaluated nonparametrically, and analyses were conducted using nonparametric tests. The one simple Wilcoxon test was used to determine the medians of a single group, the Mann-Whitney test was used for comparisons of two independent groups, the Kruskal-Wallis test was used for comparisons of more than three groups, and the Friedman test was used for repeated measurements.

Results and discussion

Case findings. A total of 79 cats with spinal instability due to vertebral trauma were evaluated in this study, among which 12 (9.48%) had endplate fractures. Of these, 2 cats (16.66%) had isolated ventral endplate fractures, 3 (25%) had fractures involving the endplate along with the middle vertebral segment, and the remaining 5 (41.66%) exhibited fractures involving the endplate together with the dorsal segment. Additionally, 2 cats (16.66%) presented with mixed fractures involving all segments (Tab. 1).

Among the 12 cats diagnosed with endplate fractures in this study, 7 (58.33%) were males and 5 (41.66%) were females (Tab. 1). The breeds included 7 Turkish Angoras, 3 Scottish Folds, and 2 hybrids (Tab. 1). The fractures were attributed to high-rise syndrome in 10 cats (83.33%), traffic accidents in 1 cat (8.33%), and the cause was unknown in 1 case (8.33%). The age range of these cats was between 8 and 13 months, with a mean of 10.58 ± 1.32 months. Their body weight ranged from 2.3 to 4.8 kg, with an average of 3.37 ± 1.06 kg.

Tab. 1. Statistical data on fracture classification, sex, breed, and etiology

Endplate fracture classification (n = 12)		Sex (n = 12)		Breed (n = 12)		Etiology (n = 12)	
Ventral	2	Male	7	Turkish Angoras	7	High-rise syndrome	10
Middle	3	Female	5	Scottish Folds	3	Traffic accidents	1
Dorsal	5			Hybrids	2	Unknown	1
Mix	2						
Mean: 2.58 Median: 3 Std. dev: 1.00		Mean: 1.42 Median: 1 Std. dev: 0.5		Mean: 1.58 Median: 1 Std. dev: 0.79		Mean: 1.25 Median: 1 Std. dev: 0.62	

Clinical examination findings. Following emergency assessment in the three steps (ABC, neurological examination, analgesia), the cats were prepared for surgery within 24 hours.

According to the severity of neurological dysfunction defined by Grasmueck and Steffen, 1 cat was

Tab. 2. Distribution of the cases according to the severity of neurological dysfunction, the location of fractures, and healing outcomes as defined by Grasmueck and Steffen (9)

Grades (I-V) n = 12		Vertebra with fractured end-plate n = 12		Recovery type n = 10	
Grade I (Back pain, no neurological deficits)	0	T9	2	Poor	3
Grade II (Ambulatory paraparesis, normal micturition)	1	T10	1	Functional	4
Grade III (Ambulatory paraparesis, urinary retention)	7	T13	3	Good	3
Grade IV (Non-ambulatory paraparesis/paraplegia, urinary retention, intact deep pain perception)	3	L2	2		
Grade V (Paraplegia, urinary retention, loss of deep pain perception)	1	L3	2		
		L4	1		
		L7	1		
Mean: 3.33 Median: 3 Std. dev: 0.77		Mean: 3.83 Median: 3.5 Std. dev: 1.64		Mean: 2 Median: 2 Std. dev: 0.82	

Tab. 3. Distribution of the cases according to the severity of neurological dysfunction

Grade		Treatment administered	Fracture location	Recovery type	Complications		
					X	Y	Z
Grade I	–	–	–	–	–	–	–
Grade II	1 Cat	VS	L4 (caudal)	Functional	+	–	–
Grade III	7 Cats	In 2 cases, VS	One case, T13 (caudal)[P]	Poor	+	+	+*
			One case, T13 (caudal)[P]	Poor	–	+	–
		In 2 cases, VS + laminectomy	One case L2 (cranial)	Functional	–	–	–
			One case, L2 (cranial)	Good	–	–	+**
		In 1 case, VS + laminectomy	L3 (caudal)	Functional	–	–	–
		In 1 case, VS + hemilaminectomy	L3 (caudal)	Good	–	–	–
		In 1 case, VS + hemilaminectomy	L7 (cranial)[F]	Good	+	–	–
Grade IV	3 Cats	In 1 case, VS	T9 (caudal)	Functional	–	–	–
		In 1 case, VS + hemilaminectomy	T10 (cranial)	Poor	–	+	–
		In 1 case, treatment declined	T13 (cranial)	–	–	–	–
Grade V	1 Cat	Euthanasia offered	T9 (cranial)	–	–	–	–

Explanations: VS – vertebral stabilization using polyaxial screws; [P] – pneumothorax; [F] – femoral fracture; X – infection in the wound line; Y – decubitus wounds; Z – implant-derived (* rod bending, ** screw loosening).

categorized in Grade II, 7 cats in Grade III, 3 cats in Grade IV, and 1 cat in Grade V (Tab. 2).

The distribution of the vertebrae with broken endplate fractures was as follows: T9 in 2 cats, T10 in 1 cat, T13 in 3 cats, L2 in 2 cats, L3 in 2 cats, L4 in 1 cat, and L7 in 1 cat (Tab. 2).

Three cats had concomitant thoracic trauma and vertebral fractures along with femoral corpus fractures; no other orthopedic problems were detected. Pneumothorax was detected in two cases where the T13 vertebra was affected, and these cases were classified as Grade III (Tab. 3).

Findings during the operation. Intraoperatively, lateral (L/L) and ventrodorsal (V/D) radiographs were taken, and the vertebra with the endplate fracture was identified on the radiographs. The area with the endplate fracture was then identified by palpation of the spinous processus, and access was achieved without any difficulty.

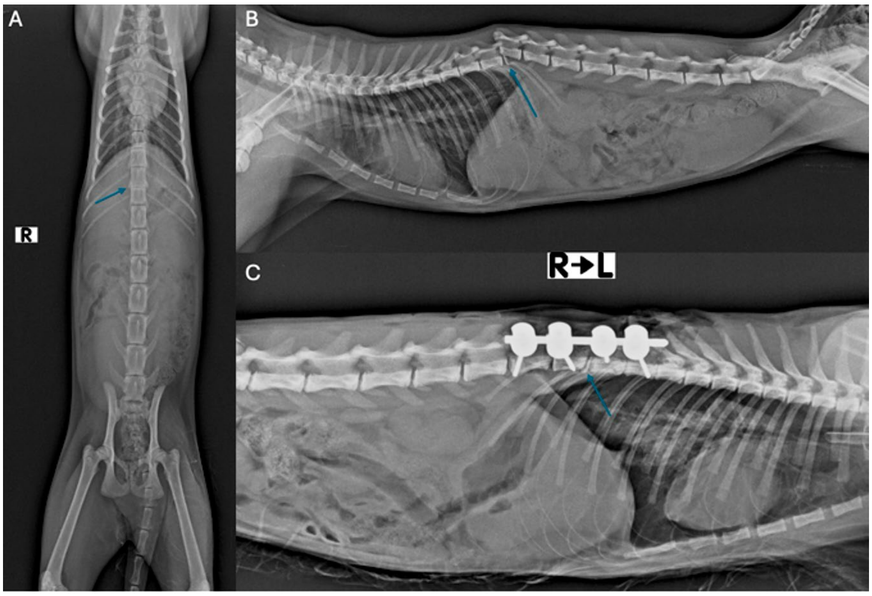

Fig. 1. Radiographic images of an endplate fracture in the T 13 (cranial) vertebra and post-fixation views. According to endplate fracture classification, it is a mixed type endplate fracture, because there is a fracture development involving the middle and ventral part of the T13.
A. Unclear fracture on a ventrodorsal (V/D) radiograph (blue arrow), highlighting the need for at least two views (V/D and L/L).
B. Clearly visible endplate fracture on a lateral (L/L) radiograph (blue arrow).
C. Postoperative control radiograph showing fixation with a polyaxial screw and rod system.

Additionally, after placement of polyaxial screws and rod connections, vertebral stabilization was achieved. In 8 cases, this stabilization was maintained in the postoperative period, whereas in the other 2 cases (one case with T13 cranial and one case with T13 caudal) control radiographs showed loss of stability in the first postoperative week (Fig. 1).

In one case, involving L1-L2, the rod detached from the clamp at the head of the polyaxial screw, which was interpreted as loosening of the screw tightening the rod on the clamp. This case was revised with a surgical procedure where the screw was replaced, and the rod was re-fixed at the same position. In another case, with a T13 endplate fracture, rod bending was observed postoperatively, but revision surgery was not performed, since stability was maintained.

In 3 of the cases evaluated within the scope of the study, skin stitches were opened, and it was observed that infection originated from the skin and subcu-

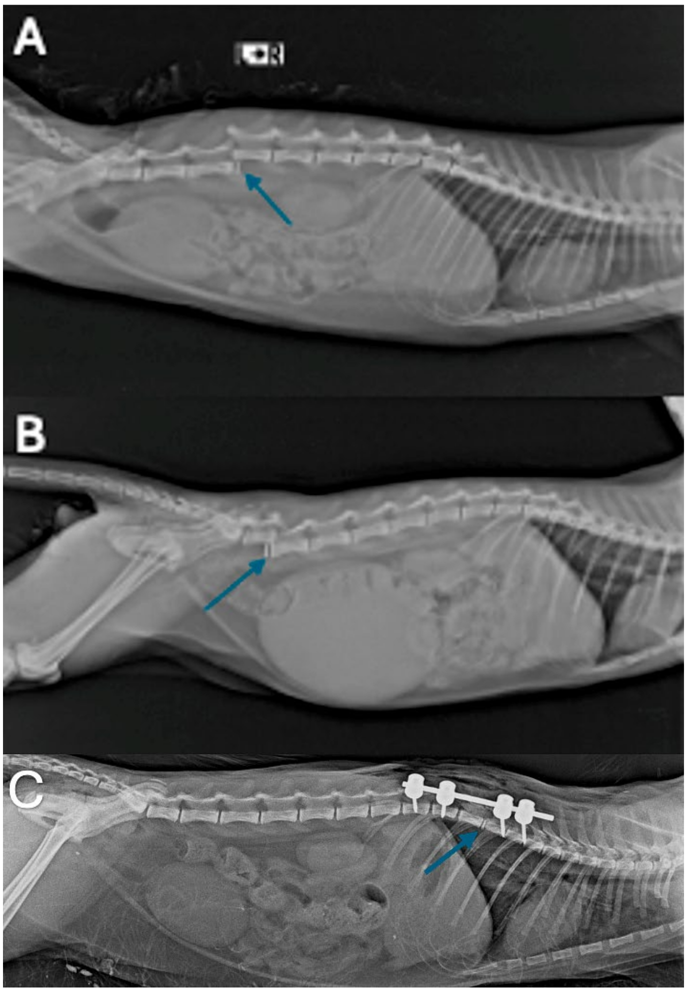

Fig. 2. Radiographic illustrations of endplate location
A. Endplate fracture caudal to L4 indicated by a blue arrow
B. Endplate fracture cranial to L7 indicated by a blue arrow
C. Endplate fracture caudal to T9 indicated by a blue arrow

taneous tissue. Of the 12 cases in total, 10 were treated, 4 of which showed functional recovery, 3 showed good recovery, and the remaining 3 showed poor or weak recovery (Tab. 2 and 3). All cases with poor healing developed decubitus ulcers, and all were related to home care conditions.

Among the cats showing functional recovery, one cat was Grade II, two cats were Grade III, and one cat was Grade IV. Two of the cats showing good recovery were Grade III and one was Grade IV. Three of the cats showing poor recovery were categorized as Grade III (Tab. 3).

None of the cases that showed functional and good recovery were suddenly unable to walk postoperatively. Only one cat was able to stand on day 5, while the others were able to stand gradually at the end of day 7, and they showed improvement by the end of week 4.

In cats, similarly to other animals, the endplate – whose structure can be considered akin to a growth plate – is critically important for the healthy development and integrity of both the vertebral column and the intervertebral disc. However, this vital structure is often overlooked in clinical assessments and studies (6). Therefore, this study focused on endplate fractures among vertebral fractures and dislocations resulting from spinal trauma in cats.

The endplate plays a critical role in nourishing the intervertebral disc via diffusion and providing mechanical support, fulfilling several important mechanical and metabolic functions. When the structure of the endplate is compromised, intervertebral discs cannot be directly nourished through blood vessels. Additionally, in cases of calcification or degeneration of the endplate, not only the endplate itself, but also the intervertebral disc, can be affected, which may lead to the development and progression of IVDD (10). Many painful conditions, such as IVDD and discospondylitis, which directly impact an animal's quality of life, may involve the potential impact of previous spinal trauma or endplate fractures and dislocations. Especially in cases of idiopathic IVDD, the endplate may be considered a contributing factor. Therefore, in situations where vertebral stabilization is compromised, restoring vertebral stability along with preserving the anatomical integrity of the endplate is of particular importance in spinal surgery. This approach is especially crucial in young animals, as it can have lifelong effects on the healthy development of the vertebral column, beyond merely facilitating the healing of a typical fracture. When vertebral stabilization is weakened or disrupted, other methods have been described, such as fixation with polyaxial screws, various plates, pins, and polymethylmethacrylate (PMMA), as well as the use of external fixators (5, 13, 17, 20). In order to avoid standardization problems arising from the technique used in our study, we preferred to use polyaxial screw and rod fixation. This technique is particularly advantageous in the thoracolumbar region because of the anatomical structure of cats, and fixation to the pedicles rather than to the vertebral body provides a great advantage.

Bali et al. reported that endplate fissure fractures account for approximately 16% of vertebral fracture cases in cats. These fractures are considered clinically significant because they compromise vertebral stability, potentially resulting in spinal trauma and spinal cord dysfunction. Motor vehicle accidents and high-rise syndrome are the most frequently reported causes, although animal bites and gunshot injuries have also been identified as important etiological factors (2). In our study, we observed that approximately 83.33% of spinal traumas were caused by high rise syndrome. We believe that this high incidence is related to the geographical location and the architectural conditions of the city. Similarly, Feeney and Oliver (7) documented physeal endplate fractures at 4% and endplate fractures at 5%. In our study, all endplate fractures were characterized by physeal separation, with a prevalence of 9.48%. The age of the cats ranged from 8 to 13 months, and the exclusive occurrence of physeal separation was associated with the young age of the animals, since vertebral epiphyseal closure typically occurs between 11 and 14 months of age (2).

With regard to the vertebrae affected by endplate fractures following spinal trauma, thoracic and lumbar vertebrae may be impacted to varying degrees. Spinal trauma may also be accompanied by thoracic injuries or other orthopedic problems, which can directly influence the survival outcomes of the animal (8). In our study, the case with a fracture at T9 was classified as grade V, and therefore, its prognosis was unfavorable. Among the other cases, one with a fracture at T10 and two with a fracture at T13 showed poor recovery outcomes despite treatment. Consequently, we believe that the location of an endplate fracture, similar to other vertebral fractures, influences the success of treatment. It is also worth noting that the cases with lumbar vertebral endplate fractures exhibited better clinical outcomes (Tab. 3).

In cases of spinal trauma with compromised vertebral stability, surgical intervention should be performed as soon as possible. The emergency management of these patients must be carried out by trained professionals. As previously described, implementing this emergency management in three steps can help shorten the time required for surgical planning (9). Early decompression and stabilization are critical for optimal outcomes in cases of spinal fracture or dislocation (6, 8). In the present study, the emergency management was evaluated according to the three-step criteria, and all patients were prepared for surgery within the first 24 hours after trauma. In this study, although patients scheduled for surgery were evaluated as emergencies, surgery could be started within 24 hours due to the stability of vital signs and life-threatening risks. For example, pneumothorax was found in two cases. Furthermore, the distribution of cases varied widely, with one case being Grade II, seven cases being Grade III, three cases being Grade IV, and one case being Grade V. We believe in the importance of performing surgery as early as 6-8 hours, but the trauma patient's preparation for surgery in terms of cardiopulmonary system stability should also be taken into consideration. On the other hand, in spinal trauma cases, prognosis varies depending on the severity and underlying condition, the overall health status of the animal, and the treatment administered. Generally, mild traumas tend to have a favorable outcome, whereas more severe injuries are associated with poorer prognoses (1, 4). Although the same technique was used for vertebral fixation in all cases included in this study, the vertebrae with endplate fractures, the source of trauma, and the severity of injury varied among patients. Consequently, the distribution of neurological dysfunctions (Grades I-V) and the affected vertebral types (T9-L5) also differed (Tab. 2 and 3). Regarding clinical outcomes, 3 cases showed good recovery, 4 cases achieved functional recovery, and 3 cases had poor recovery. The poorer recoveries were observed predominantly in thoracic vertebrae, for which, due to their anatomical structure, prognosis tends to be less favorable than it is for lumbar vertebrae.

In cases of neurological dysfunction due to spinal trauma, although nerve activity may return after spinal surgery, animals often do not retain muscle tone sufficient for movement. This is because the animal cannot move before nerve function is restored, which leads to inevitable muscle atrophy and loss. Implementing passive exercises and physical therapy during the postoperative period is therefore crucial to prevent muscle strength loss and muscle atrophy (5). In our study, postoperative follow-ups indicated that nerve activity developed gradually over time rather than suddenly. We believe that instructing pet owners in the use of passive exercises and encouraging them to implement such exercises after discharge can be beneficial to the treatment process.

Cats with good, functional, or poor recovery had different grades. Standardization of clinical cases may not always be possible. The results of this study did not establish a direct correlation between grade and recovery. Because the extent of spinal cord involvement in these patients is unknown, home care is as crucial as surgical success. Home care conditions were particularly challenging for patients with poor recovery compared to other patients.

In this study, no radiological findings were evaluated other than the continuity of vertebral stabilization and changes in the positions of polyaxial screws and rods. However, we recommend monitoring for complications, such as IVDD or vertebral developmental disorders, as well as evaluating fusion, callus formation, or radiological healing, and conducting longer-term follow-up in subsequent studies related to end-plate fractures. This study has several limitations, including its retrospective design, small sample size, lack of advanced imaging (CT/MRI), short follow-up period, and absence of a control group. Consequently, the findings should be interpreted as preliminary descriptive observations rather than definitive evidence regarding prognosis or optimal treatment strategies. Larger prospective studies with long-term follow-up are needed.

A comprehensive evaluation of the data obtained in our study demonstrates that in cases where the endplate is affected, complete anatomic reduction of the endplate is necessary to preserve vertebral health, and care must be taken to minimize soft tissue damage to maintain local blood circulation to the vertebra and the endplate. In young animals, even if vertebral stability is intact, the distance between the endplate and the vertebral body should be assessed on radiographs.

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