

Clinical and etiologically evaluation of cats with high-rise syndrome: assessment of 72 cases (A retrospective study)

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ABSTRACT

Surgical problems observed in cats after falling from balconies or windows of buildings are significant, and this phenomenon of falling from a height is known as high-rise syndrome (HRS). The purpose of this study was to clinically evaluate frequently encountered cases of cats falling from a height. Overall, 72 cats of different breeds, ages and sexes brought to Dicle University, Faculty of Veterinary Medicine, Department of Surgery, with complaints of falls from a height in 2019 were included. Falls from a height are more common during summer. Orthopaedic problems are common (58.33%), and femoral fractures (23.61%) constitute an important part of them. The affected cats were aged mostly under the 1 year. Furthermore, the survival rate of these cats was found to be 95.8%. In conclusion, the main purpose for the treatment of cats with HRS should be to stabilise their general condition and subsequently correct orthopaedic and/or soft tissue damage.

INTRODUCTION

High-rise syndrome (HRS) is the phenomenon of cats falling from balconies and windows of buildings with usually ≥ 2 stories (1-6). Findings from literature indicate that trauma caused by falling from a height has a rate of 50% among all the traumas seen in cats (7) and that falling from a height is the second most common cause of trauma following traffic accidents (8). The main reason for falls is often considered to be that cats want to play. However, jumping out of a balcony or window; slipping while walking on a balcony or window-sill; and chasing a fly, insect or bird may also play a role in falling (2-4). HRS is observed more frequently in young cats owing to behavioural differences between young and old animals (3,5,9). This syndrome may involve various injuries (2,6). The survival rate of cats is approximately $\geq 90\%$ (5,6,10-12). Although results of some studies indicated that the severity and intensity of trauma is associated with the height a cat falls from (3,10), Pratschke and Kirby (2) reported that this cannot be generalized.

According to Papazoglou et al. (10), approximately 50% of cats with HRS owing to falling from a height have lesions in

the extremities, and cases of falls are generally more common in young old cats.

The aim of this study was to clinically and etiologically evaluate cats brought to Dicle University, Faculty of Veterinary Medicine, Department of Surgery, with complaints of falls from a height in 2019.

MATERIAL and METHODS

The study included 72 cats with different breeds, ages and sexes that were brought to Dicle University, Faculty of Veterinary Medicine, Department of Surgery, with complaints of falls from a height in 2019. In order to carry out this study, permission was obtained from the local ethics committee of Dicle University with the number E-35582840-604.01.01-133503. The cats that fell from the $\geq 2^{\text{nd}}$ floor were included in the study. All cats first underwent major trauma protocol. At this stage, respiratory tract, breathing and circulation were evaluated and oxygen support was provided to all patients. After the general condition of the patient stabilized, a detailed clinical and radiological examination was performed for these cats. Furthermore, in first medical intervention for all cats un-

der observation, all cats included in the study were injected with tranexamic acid (10 mg/kg, Transamin® 5% ampoule, Teva, IV) and methylprednisolone (20 mg/kg, Prednol L® 20 mg, Mustafa Nevzat, IM) for a possible internal bleeding and possible shock; fluid support (10-20 ml/kg, %0.09NaCl®, Baxter, IV and 5 ml/kg, Hetastach %6, Novaplus® IV) was provided for those with an unstable haemodynamic status. Hetastach 6% was used in combination with 0.09% NaCl in patients with pale mucosa, prolonged capillary filling time, and weak or no sense of the pulse.

The scoring technique previously described by Vnuk et al. (3) was used to determine the severity of the lesion or injury. Score 1 was evaluated as contusions, abrasions, wounds, lacerations, pulmonary contusions, haematuria, epistaxis, dental fractures score. Score 2 was evaluated as limb fractures, limb luxations, hard palate fractures, mandibular fractures, pelvic fractures, temporomandibular joint luxations, haemothorax, pneumothorax, abdominal wall rupture, diaphragmatic rupture, rupture of urinary bladder, vertebral fractures / luxation score. If there are multiple problems or fractures, the sum of the score values was taken.

Support bandage was applied for non-dislocated fractures (n = 6), whereas one of the osteosynthesis techniques, such as intramedullary nailing, external fixator or plate application, was performed according to localisation and shape of the fracture for dislocated fractures. In vertebral fractures, dorsal laminectomy was performed in addition to cage rest. In cases of luxation, open reduction and De Vita pin technique were used. In cats with cleft palate (n=3), repair was done with simple separate sutures (palatorrhaphy). In addition, it was recommended to feed juicy and soft foods. No diaphragmatic hernia was found in any of the cats.

Following sedation (2-3 mg/kg Xylazin HCl [Rompun®, Bayer 20 mg/ml/im]), operative procedures were performed

under dissociative general anaesthesia (10–20 mg/kg dose of ketamine HCl [Ketaso®, Interhas, 100 mg/ml]). Amoxicillin (Alfoxil® 125 mg/5 ml oral suspension Fako Ilac Co., for 7 days) and meloxicam (Metacam® 20 mg/ml IV, for 3 days) were administered to cats that underwent surgery. The operated cats were clinically checked at certain times for 2 months postoperatively.

Two cats died without undergoing any procedure.

Statistical analysis

Statistical analysis of the data was performed using the Minitab-17 software package. All data from the study were considered nonparametric, and for calculations Kruskal-Wallis test used. Median and Z values were calculated.

RESULTS

From our records, it was determined that 389 cats were brought to Dicle University, Faculty of Veterinary Medicine, Department of Surgery, in 2019, and 18.5% (72 cases) of these cats were brought with complaints of falls from a height.

Of the cats brought to the university, 39 (54.16%) were female, and 33 (45.83%) were male; 43 cats (59.72%) were aged under 1 year, 8 (11.11%) were aged 1 year, 7 (9.72%) were aged 1-2 years, 7 (9.72%) were aged 2 years, 5 (6.94%) were aged 3 years and 2 (2.77%) were aged 8 years.

According to seasonal distribution, it was determined that 3 of the cats were brought to our hospital in January, 1 in March, 4 in April, 4 in May, 3 in June, 5 in July, 11 in August, 26 in September, 8 in October, 4 in November and 3 in December.

Information on anamnesis revealed that 3 cats fell from the 10th floor, 1 from the 9th floor, 3 from the 8th floor, 6 from the 7th floor, 6 from the 6th floor, 14 from the 5th floor, 18 from the 4th floor, 13 from the 3rd floor and 8 from the 2nd floor. In cats

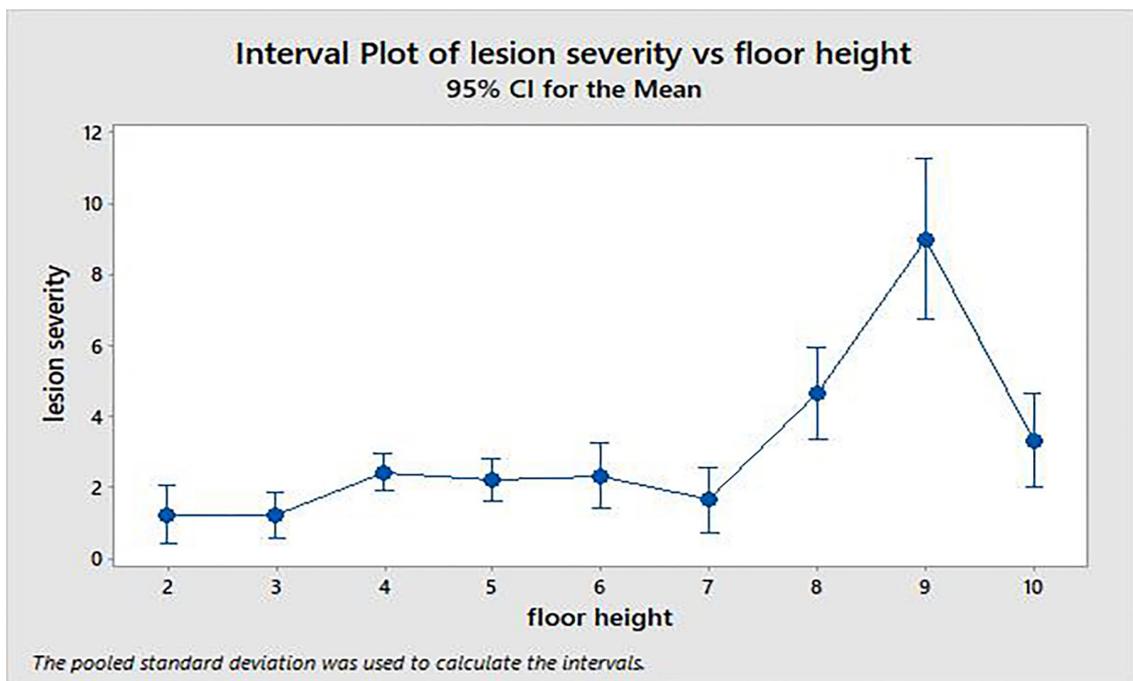


Figure 1. Statistical comparison of floor height and lesion severity

Table 1. Diagnoses made in clinical and radiological examination and treatment modality.

Lesioned area	Diagnosis	Number of cases	%	Medain	Z value	Type of operation or treatment
Head and neck region	Cleft palate	3	4.16	3	0.95	Palatorrhaphy
	Fracture of the mandible	1	1.38	1	-0.61	Nutrition edited
Thorax region	Emphysema	1	1.38	1	-0.61	It's been supervised
Forelimb	Humerus fracture	4	5.55	4	1.13	Intramedullary pinning, intramedullary pinning and cerclage wire
	Antebrachium fracture	7	9.72	7	1.39	Intramedullary pinning, plate, supported bandage
	Ulna fracture	1	1.38	1	-0.61	Supported bandage
	Radius fracture	1	1.38	1	-0.61	Supported bandage
	Metacarpus fracture	2	2.77	2	0.69	Intramedullary pinning and supported bandage
	Elbow joint dislocation	1	1.38	1	-0.61	Open reduction
Hindlimb	Femoral fracture	18	23.61	18	1.65	Intramedullary pinning, cross pinning, intramedullary pinning and cerclage wire
	Coxofemoral luxation	1	1.38	1	-0.61	De vita pinning
	Tibial fracture	7	9.72	7	1.39	Supported bandage, intramedullary pinning and cerclage wire, external fixation
	Tarsal joint luxation due to talus fracture	1	1.38	1	-0.61	Arthrodesis
Pelvis region	Ilium fracture	2	2.77	2	0.69	Cerclage wire
	Sacroiliac separation	1	1.38	1	-0.61	Cage rest
Spine region	Thoracic vertebrae fracture	1	1.38	1	-0.61	Cage rest
	Lumbal vertebrae fracture	1	1.38	1	-0.61	Cage rest
	Lumbal vertebrae luxation	1	1.38	1	-0.61	Dorsal laminectomy
Soft tissue	Crushed	1	1.38	1	-0.61	Medical treatment
	Tibial paralysis	1	1.38	1	-0.61	Medical treatment

with HRS, floor height and scored lesion severity is shown in figure. The 2 cats that died were not statistically evaluated. It was determined that 61 of these cats fell on a concrete ground, 3 fell on grass, 7 fell on soil and 1 fell on a concrete ground after hitting a tree.

For 22 cats (30.55%), there were no findings based on the clinical and radiological examinations, and 2 cats (2.77%) died without undergoing any examination or treatment. During their 2-week follow-up via phone, 22 cats were found to have continued their lives without any problem. The diagnoses made in the clinical and radiological examinations and treatments performed in other cases are summarised in table.

In these cats, distal femoral fracture and antebrachium fracture were observed in 1 cat, metacarpus and collum femoris fracture in 1, cleft palate and soft tissue damage in the left forelimb in 1, diaphyseal femur fracture in one leg and collum femoris fracture in the other leg in 1, bilateral antebrachium fracture in 1, bilateral tibial fractures and thorax emphysema in 1, and antebrachium fracture in a leg and radius fracture in the another leg concurrently in 1. According to the scoring technique of Vnuk et al. (3), the lesion severity was determined to be between 0 and 9 in this study. The cat with the highest score had bilateral tibia fracture and emphysema in the thorax. In this case, spontaneous respiration was present. Oxygen supplementation was given. It was waited for osteosynthesis until the general condition of the cat completely recovered.

In the cat that was paraplegic before dorsal laminectomy, recovery was achieved in one leg after dorsal laminectomy, whereas numbness persisted in the other leg. Physical therapy was recommended to strengthen the muscles in the improved leg, and amputation was recommended for the other leg. Amputation was not performed because the owner did not want it. In the cat with a mandible fracture, surgery was not performed because when the cat was brought to the clinic, callus tissue was formed. It was recommended that the cat should be fed with a soft-food diet. It was learned that one cat that underwent osteosynthesis died 2 days after the surgery and that all the other cats regained their health. Consequently, the survival rate was 95.8% in cats with HRS.

DISCUSSION

HRS occurs mostly in urban areas with tall buildings (3,9,10). HRS is mostly seen in young cats owing to behavioural differences between young and old animals. Kittens may fall from a balcony or window when they run around or see a moving object or bird. (3,9). Keeping balconies and windows open, especially during summer, makes it easy for cats to reach these areas. Therefore, in this study, clinical and etiologically evaluation of cats that were brought to Dicle University, Faculty of Veterinary Medicine, Department of Surgery, with complaints of falls from a height in Diyarbakır, where the temperature is extremely high during summer, in 2019 have been discussed.

Previous researchers reported that HRS may be associated with age, and this may be associated with acquired experience more (3,10). Regarding cats with HRS, Vnuk et al. (3) reported a mean age of 1.8 years, and Papazoglou et al. (10) reported a mean age of 1.2 years. In our study, the mean age of such cats was found to be 1.11 years. Results of previous studies (3,10) and those from our study confirm that there may be a relationship between falling from a height and young age (under 2 years).

Although HRS is a term used with respect to cats that fall from ≥ 2 floors and the relationship between height and severity of injury or trauma may not be fully explained, in the studies conducted by Papazoglou et al. (10) and Vnuk et al. (3), it has been reported that there is a relationship between height from which cats fall and lesions and that the severity of lesions increases with height. However, Pratschke and Kirby (2) as well as Tuzun and Saglam (4) stated that lesions in cats are not associated with height. In our study, the severity of the lesion was found higher on the 9th floor, but since there is only one cat, generalization cannot be made with these data.

Cats often fall off the balcony or window sills. There is a correlation between increasing temperatures and number of falls because windows are kept open in summer (3,10). Vnuk et al. (3) reported that 65% cats fell between April and September, and Papazoglou et al. (10) reported that 84% cats fell between March and November. In this study, it was observed that the incidence of falls from a height between May and October was 81.4%.

Robinson (13) described HRS with the trio of epistaxis, hard palate fracture and pneumothorax. Vnuk et al. [3] re-

ported that they diagnosed epistaxis in 8.4% cats, hard palate fracture in 5%, thoracic trauma in 33.6% and pneumothorax in 20%; Papazoglou et al. (10) reported that they diagnosed epistaxis in 2% cats, hard palate fracture in 3%, thoracic trauma in 13% and pneumothorax in 4%. In our study, nasal bleeding was not encountered, but a cat with thoracic trauma (1.38%) was brought to our clinic.

Ozaydın (14,15) is predisposed to trauma due to the fact that the thorax forms a large part of the body, and its importance increases with the presence of two vital organs such as lung and heart, he also reported that lesions such as pneumothorax, hemothorax, airway obstruction and pericardial hemorrhage that may be formed as a result of trauma are life-threatening conditions. Two cases with dyspnea and tachypnea brought to our clinic were ex, despite all attempts before a detailed examination was made. Clinical symptoms suggested the presence of thoracic trauma. In addition, no hard palate fracture was detected in our study, and cleft palate was observed in 4.2% cats.

Extremity injuries are frequently encountered in cats with HRS (3,5,11,16). Extremity fractures were reported at a rate of 42.9% by Collard et al. (11), 48% by Merbl et al. (5), 46% by Vnuk et al. (3), and 50% by Papazoglou et al. (10). In our study, the limb (fore and hind) fracture rate was 48.5%. In addition, the rate of pelvic fracture in cats with HRS, Merble et al. (5) and Vnuk et al. (3) reported as 15.9% and 9%, respectively. In our study, this rate was found as 2.77%. Furthermore, vertebral fracture and luxation occurred at a rate of 4.16%. Therefore, in cats that fell from a height, an orthopaedic examination should be performed for long extremities and the whole body.

Approximately 50% extremity fractures caused by trauma are long extremity fractures, and approximately 50%–60% of these fractures are femoral fractures (17-19). Some researchers have reported that more fractures are formed in the hindlimb in cats with HRS (3,10,16). Vnuk et al. (3) reported that the forelimb and hindlimb ratio is 5/8; Papazoglou et al. (10) reported this ratio to be 1/2. Other researchers (20,21) have argued that the ratio of the forelimb to hindlimb is equal. In our study, this ratio was found to be 3/5. In addition, we mostly encountered femoral fractures in our study. Femoral fracture accounted for 25.5% cats with HRS, and 48.5% of those fractures were caused after falling from a height. Therefore, femoral fractures may be encountered as a result of falling from a height, traffic accidents or many other traumas.

Some argue that femoral fractures (40%–46% of all fractures) occur more frequently in cats falling from a height (10,20), whereas some authors (3) stated that tibia fractures are more common (36%) than femoral fractures, and the latter take the second place (24%). They reported that in femoral fractures, fracture occurs in the distal part in 79% cats (3) and that the age of cats with femoral fractures is under 1 year (3,10,16). In our study, distal femoral fractures accounted for 66.6% cats with femoral fractures. In our study, cats with affected femurs were younger. Also, the closure of the epiphysis growth plate is effective.

They reported that in femoral fractures, fracture occurs in the distal part in 79% cats (3) and that the age of cats with femoral fractures is under 1 year (3,10,16). In our study, distal femoral fractures accounted for 66.6% cats with femoral fractures. The mean age of the cats with femoral fractures was 7.5 months. This can be explained by the fact that femoral fractures mostly occur in the distal section near the growth area.

When the cases of falling from a height in cats and dogs were compared, it was stated that the anterior extremity fractures were more common in dogs and the reason for this was that the dogs put a load on the anterior extremity first (3).

The results of the studies showed that the severity of bone and soft tissue damage increased linearly up to the 7th floor; after the 7th floor, tissue damage and the incidence of bone fractures decreased. Only one of the 22 cats that fell from the 7th floor died, and only one fracture was identified among 13 cats that fell from the 9th floor (3,20). Conversely, there are authors who argue that generalisation cannot be made for this condition and that there are cats experiencing mild or moderate trauma despite falling from a height (2,4). In our study, the severity of the lesion was found higher on the 9th floor, but since there is only one cat, generalization cannot be made with these data.

There are studies reporting different opinions regarding the use of corticosteroids in the treatment of trauma patients. Some researchers (22-24) reported that corticosteroids can be used in trauma patients, emphasizing that they increase cardiac output, decrease systemic and pulmonary vascular resistance, increase tissue perfusion and decrease the incidence of pulmonary thromboembolism. However, some researchers (25,26) argued that it may cause traumatic shock, increase morbidity and mortality by causing an increase in hyperglycemia, pneumonia risk and blood urea level in trauma patients, and did not recommend its use in trauma patients. They also emphasized that more studies are needed on the use of corticosteroids in trauma patients. In this study, methylprednisolone was applied and no related adverse events were experienced.

According to many researchers, cats with HRS have a good chance of survival (3,10,11). The survival rate of cats was reported to be 97% Collard et al. (11), 88%–97.3% by Merbl et al. (5) and 93% by Papazoglou et al. (10). In this study, we found a survival rate of 95.8%.

CONCLUSION

In conclusion, cats with HRS can survive falls because they are mildly affected owing to fall physics and their highly developed vestibular systems and extenuating reflexes; in cases of moderate or more severe conditions, cats can regain their health with appropriate emergency management and planned effective treatment. For cats with HRS, the first objective should be to stabilise the general condition. After the overall condition of the cat has improved, interventions for orthopaedic and soft tissue trauma should be planned. It may also be helpful to advise cat owners of measures to be taken to prevent HRS.

DECLARATION

Ethics Approval

In order to carry out this study, permission was obtained from the local ethics committee of Dicle University with the number E-35582840-604.01.01-133503.

Conflict of Interest

There is no conflict of interest.

Author contribution

Idea, concept and design: EC

Data collection and analysis: EC, SA, BEK, SY, NS

Drafting of the manuscript: EC

Critical review: EC, SA, BEK, SY, NS

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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