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Research Article

Evaluation of Factors Affecting Prognosis in Traumatized Cats

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Abstract

This study aims to evaluate the factors affecting the prognosis of cats presented with trauma complaints based on the type of trauma, clinical scoring (ATT and mGCS), laboratory measurements, and radiographic examination findings. The study materials consist of clinical (Animal Trauma Triage (ATT) Glasgow Coma Scale (mGCS), radiographic examinations, and laboratory analyses of a total of 50 cats of various breeds, ages, and weights, admitted to the Animal Hospital of the Faculty of Veterinary Medicine at Selcuk University with trauma complaints. According to clinical examination findings, the mean ATT was 3 in surviving cats and 8 in deceased cats, while the mGCS score was 17 in surviving cats and 14 in deceased cats. The results were statistically significant in deceased cats. Radiographic examinations revealed that thoracic and abdominal trauma were more common in deceased cats. Laboratory results showed statistically significant correlations for BUN, total protein, albumin, hematocrit, and red blood cell levels, with notable differences between surviving and deceased cats. It is suggested that the systematic application of these diagnostic tools will improve prognostic accuracy for traumatic injuries in cats and lead to better management and treatment outcomes. Additionally, future studies on traumatized cats should consider repeating analyses at specific intervals during the treatment process to better identify prognostic factors that influence mortality.

Keywords: ATT, Cat, mGCS, Trauma

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Introduction

Trauma results from an external force causing tissue damage, such as a wound or laceration (Drobatz 2011). The free-spirited and independent nature of cats, along with their tendency to quickly become bored in a single environment, increases their risk of experiencing trauma (Parlak and Arican 2016, Klainbart et al 2022). Traumatic injuries account for 12-13% of cases seen by veterinarians, with the most common causes in cats being traffic accidents, falls from heights, bite wounds, and unknown factors (Kolata et al 1974, O'Neill et al 2014). Young male cats that go outdoors are particularly at higher risk for traumatic events (Buffington 2002, Rochlitz 2003).

Trauma-related mortality rates in cats range from 9% to 27%. In veterinary emergency medicine, the absence of widespread prehospital care guidelines has resulted in limited data on the timing of trauma-related deaths. Because pets that died at the scene were not included in the analysis, accurately assessing mortality rates is challenging. Determining the time of death can help manage the financial and emotional expectations of pet owners and veterinary staff, as well as inform appropriate monitoring and treatment plans (Hickey et al 2021).

Research on trauma-related deaths in the veterinary literature has primarily focused on dogs, leading to limited data on cats. Prognostic factors reported in cats include general complications (Hernon et al 2018), cardiopulmonary arrest during surgery (Lux et al 2018), multiple organ dysfunction syndrome (MODS) (Murgia et al 2019), and increased Animal Trauma Triage (ATT) scores (Gant et al 2019). However, the small sample sizes in these studies limit the statistical evaluation of prognostic variables related to the timing of death.

The aim of this study is to identify factors affecting prognosis by evaluating the causes of trauma, ATT

and modified Glasgow Coma Scale (mGCS) scores, laboratory findings, and radiographic examinations of cats presented to our clinic due to trauma.

Material and Methods

This study was approved by the Selcuk University Animal Experiments Local Ethics Committee (Approval no: 2023/117). The material of the study consisted of a total of 50 cats of different breeds, ages and weights brought to the Animal Hospital of the Faculty of Veterinary Medicine at Selcuk University with complaints of trauma in with complaints of trauma. In the study, cats were divided into two groups and compared: Group 1 consisted of cats that survived trauma, and Group 2 consisted of cats that died after trauma. The ATT and mGCS scores of both groups and the biochemistry and blood analysis results were compared.

Clinical and Laboratory Evaluations

During the clinical examinations of the traumatized cats, Animal Trauma Triage (ATT) and modified Glasgow Coma Scale (mGCS) scores were performed, respectively. After the clinical examination, a vascular access was established from the cephalic vena for fluid and electrolyte replacement, biochemical and hematological analyses and fixed. Radiometer ABL90 Series (England) device was used to perform blood gas analyses from venous blood taken from the cases, MS4e Hematology Device (France) for hemogram analyses, and BT 3000 Biochemical Analyzer (Italy) for measuring biochemical parameters.

Radiographic Examination

After the respiratory and circulatory systems were stabilized, radiographic examinations (SIEMENS X-ray, Rayence Veterinary DR Device) of the traumatized cats were performed in line with clinical indications.

Surgical Intervention and Postoperative Care

After completing the clinical, laboratory, and radiographic examinations, traumatized cats were treated with the flow by and/or oxygen and fluid-electrolyte (isotonic 0.09%, colloid) in the intensive care cage according to their perfusion status. Cats with head trauma were also given mannitol and hypertonic saline and intensive care follow-up was performed. 0.1 mg/kg of butorphanol hydrogen tartrate (Butomidor®-Interhas) was used in all traumatized cats for analgesic purposes.

In accordance with the indications, operative procedures of traumatized cats were postponed until their vital signs returned to normal. For necessary operative procedures (orthopedic surgery, soft tissue surgery, etc.), 0.1 mg/kg butorphanol hydrogen tartrate (Butomidor®-Interhas) and 0.025 mg/kg medetomidine hydrochloride (Domitor®-Zoetis) were injected intramuscularly as preanesthetics. For induction anesthesia, 1.5-3 mg/kg propofol (Propofol-Lipuro® 1%) was injected intravenously and anesthesia was maintained with isoflurone.

Statistical Analysis

The Mann-Whitney U test was used to compare ATT and mGCS scores between groups, and the Independent T-test was used to compare biochemistry and blood parameters.

Results

Of the 50 traumatized cats evaluated, 35 (70%) survived, while 15 (30%) died. The average age of the 35 surviving cats was determined as 20 ± 1 (months), and the average age of the 15 deceased cats was determined as 19 ± 1 (months). The breed distribution of the cats was as follows; 32 (64%) were tabby (hybrid), 2 (4%) were Ankara cats, 4 (8%) were Scottish Fold, 9 (18%) were British Shorthair, 2 (4%) were Persian and 1 (2%) was Van cat. Of the total 50 traumatized cats, 30 (60%) were male and 20 (40%) were female. The average weight of the surviving traumatized cats was determined as 2.7 kg, while the deceased cats were determined as 3.08 kg.

The distribution of the causes of trauma in the 35 surviving cats; 7 (20%) traffic accidents, 1 (2.86%) dog attacks and 26 (77.14%) falls from heights; the distribution of the causes of trauma in the 15 cats that died was determined as 11 (73.3%) traffic accidents and 4 (26.7%) falls from heights.

When the ATT and mGCS results of both groups were compared statistically in traumatized cats; it was found to be statistically significant in both scores (Table 1). According to the clinical and radiographic examination findings of the traumatized cats examined in the study, the head and neck region stands out as one of the least affected regions as a result of the fall. In cases where the head and neck region were affected due to trauma (especially in the deceased cat group), palatoschisis, epistaxis, occlusion disorder, and canine tooth fractures were observed (Figure 1 and Figure 2).

Findings detected in the thoracic and abdominal regions of the cases after trauma; pneumothorax was seen in 8 of the 31 surviving cats, pneumothorax in 3 of the 15 deceased cats, pleural effusion in 2 cases, and hernia diaphragmatica in 1 case.

In the pelvic region, the most common fractures due to trauma were the ilium, acetabulum, ischium fractures, and sacroiliac separations. In the extremities, the most common fractures were the femur, tibia, and metacarpal fractures in the surviving group, and comminuted femur fractures and sacroiliac separations in the deceased cases (Figure 3).

Table 1. Statistical values of ATT and mGCS scores of 50 traumatized cats			
Parameters	Survivors(n:35)	Nonsurvivors(n:15)	P value
ATT	3	8	0,001
mGCS	17	14	0,001
ATT; Animal Trauma Triage Scoring, mGCS; Modified Glascow Coma Scale.			

	Table 2. Serum Biochemistry, Hemogram and Blood-Gas intervention of 50 traumatized cats			
	Parameters	Survivors(n:35)	Nonsurvivors(n:15)	P value
Serum Biochemistry	BUN (Min-Se)	23,40±3,00	48,00±9,60	0,026
	Creatin	1,17±0,19	1,63±0,45	0,367
	Glucose	185,90±11,00	230,30±22,00	0,082
	ALT	283,00±60	289,00±86,00	0,951
	ALP	90,00±18,00	53,30±13,00	0,098
	Phosphore	5,80 ±0,34	7,60±0,90	0,079
	Cholesterol	142,90±7,30	135,40±10,00	0,563
	Total Bilirubin	1,01±0,26	0,63±0,10	0,183
	Albumine	3,63±0,12	2,86±0,09	0,001
	Total Protein	6,74±0,15	6,03±0,17	0,004
Hemogram	WBC	19,20±2,70	20,90±3,30	0,688
	RBC	9,64±0,32	7,45±0,43	0,001
	HCT	44,27±1,70	34,70±2,10	0,001
	HB	12,90±0,47	11,07±0,61	0,024
	THR-PLT	125,00±17,00	144,10±25,00	0,534
	PCT	0,23±0,06	0,15±0,03	0,272
Blood-Gas findings	PH	7,34±0,01	7,18±0,07	0,044
	pCO_2	33,85±1,00	37,10±3,50	0,384
	pO_2	37,50±4,60	68,70±10,00	0,010
	Lactate	2,68±0,25	3,20±0,52	0,374
	HCO_3^-	17,25±0,91	14,59±1,60	0,158

When laboratory examinations performed in traumatized cats were compared between the surviving and deceased (Table 2); a statistically significant correlation was observed between blood urea nitrogen (BUN), Albumin, Total Protein, Red Blood Cell (RBC), Hematocrit (HCT), Hemoglobin (Hg), pH, partial oxygen pressure (pO_2), which would negatively affect the prognosis in the deceased group.

Discussion

According to the study, the survival rate after trauma was found to be 70%. This rate is lower than the survival

Figure 1. Image of cats brought to the clinic due to trauma A. Case of proptosis, epistaxis and hyphema due to trauma. B. Case of canine tooth fracture due to falling from a height.

rate (83%) previously reported by Gregory et al. (2023), but higher than the rates (62.3%) reported by Kelley et al. (2023). It is thought that the difference here is due to the different number of animals included in the study (Kelley et al 2023). In studies conducted on cats, it is reported that young cats are more likely to be exposed to trauma; however, in our study, it was observed that the probability of cats encountering traumatic events was not significantly related to age (Umphlet and Johnson 1988, Lopes et al 2005). In our study, the mean age of the cases was 19.20 and 18.93 months, respectively, Kelley et al (2023) (42 and 63.4 months), Umphlet and Johnson (1988) (29.5 months) and Lee et al (2022) it was found to be lower than (36 months) and higher than Mulherin et al (2014). Cojocaru et al (2021) reported in their study on traumatized cats that the majority of cases were cats aged 24-60 months; however, due to the differences in the age scales of the patients in our study and other studies, no statistically significant relationship was observed between age distribution and trauma-related survival rates.

In a study conducted by Lee et al in 2022, it was observed

Figure 2. Epistaxis, respiratory depression, palatoschisis, symphysis mandibular fracture and epistaxis in a cat due to a traffic accident.

that patient gender was statistically significantly associated with the outcome and that male cats (66%) were more likely to be exposed to trauma than female cats (34%). Previous studies have also reported that male cats are more likely to wander, fight and experience trauma (Buffington 2002, Rochlitz 2003). In our study, although the incidence of trauma was higher in male cats, the mortality rate was lower than in female cats. It is thought that male cats are anatomically and physiologically more resistant to trauma than female cats, and that the severity and type of trauma may also have an effect on this issue.

When the breeds of cats exposed to trauma in our study were evaluated, it was seen that the most commonly traumatized breeds were tabby (64%), British Shorthair (18%) and Scottish Fold (8%), respectively. Cojocaru et al (2021) stated in their study that the cat breeds exposed to trauma were European Shorthair (89.2%), Birman (6.7%) and Persian cat (1.83%). Lee et al (2022) also stated in their study, parallel to our study, that almost 90% of the cats exposed to trauma were tabby. It is estimated that the reason for this may be due to the fact that the majority of the stray cat population in our country (Türkiye) consists of tabby cats.

Lee et al (2022) reported that the most common causes of trauma in cats were falling from heights (24.0%), traffic accidents (21.3%), and bite wounds (7.6%). However, in their study, 22.6% of the cases brought with complaints of trauma were cats with unknown causes of trauma. Lee et al (2022) reported that the majority of the cases were falling from heights, traffic accidents, and dog attacks, respectively. In their study, Cojocaru et al (2021) reported that the causes of trauma were traffic accidents (32.23%), bite wounds (15.69%), falls from heights (13.47%), and cases with unknown causes (15.71%), respectively. When we compare our study results with other literature, it is

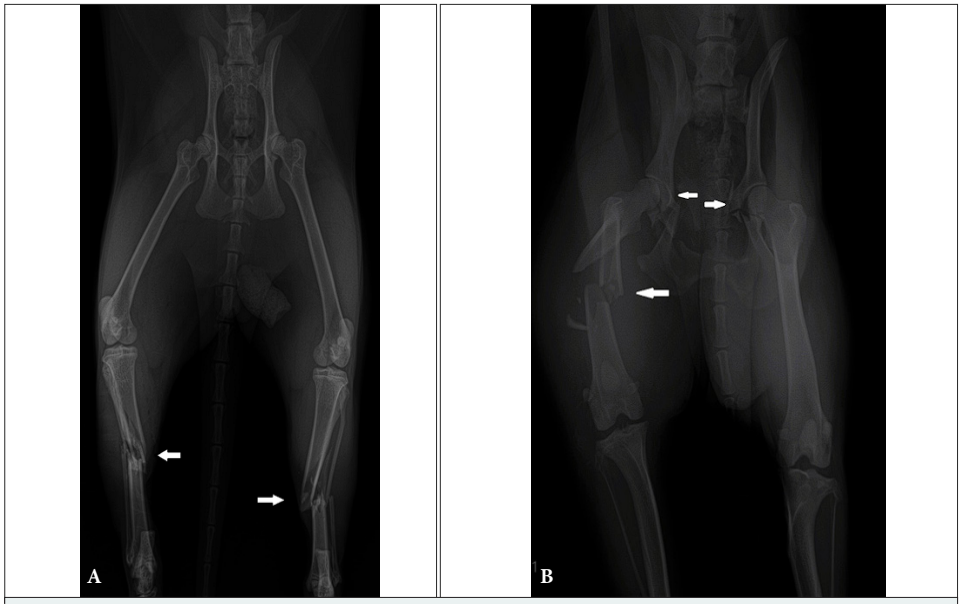

Figure 3. Multiple fractures due to trauma in cats, A.Bilateral tibial comminuted fracture, B.Right femur comminuted fracture and bilateral acetebulum comminuted fracture.

thought that the reasons for the differences in trauma etiology may be due to the socio-economic structures of societies, means of transportation, the number of owned and unowned cats, and the different policies of countries for unowned animals.

Studies using the Animal Trauma Triage scoring system have shown that the risk of death increases as signs of shock develop in patients (Rockar and Drobatz 1994, Pınar and Arıcan 2022). In a study evaluating 25 traumatized cats that fell from a height, it was observed that ATT scoring was significantly associated with mortality and that the mortality rate was higher in traumatized cats with high ATT scores (Murgia et al 2019, Girol-Piner et al 2022). It is said that every 1-point increase in ATT scoring increases the mortality rate by 1.78 times (Lapsley et al 2019). The mGCS and ATT cumulative scores, which have been confirmed in previous studies, were significantly associated with our study results. These results are consistent with previously validated scales and show that low mGCS and high ATT scores at the time of initial presentation are negative prognostic indicators for survival in feline trauma patients (Lee et al 2022, Kelley et al 2023).

When the ATT scores of traumatized cats were examined in our study, it was observed that the ATT scores of deceased cats were higher statistically significant. In line with other literature, it is seen that ATT scoring has a prognostic feature in cats exposed to trauma in our study. It has been suggested that the Modified Glasgow Coma Scale can be used in the evaluation of systemic shock in patients with impaired motor function and consciousness due to perfusion abnormalities (Lapsley et al 2019). It is said that the Modified Glasgow Coma Scale gives positive results in terms of prognosis even in the evaluation of patients with unknown etiology (head trauma or suspected injury) and is important in revealing hidden head traumas that are difficult to diagnose in many multitrauma patients in veterinary medicine (Ash et al 2018). When mGCS scores were compared between the surviving and deceased groups in our study, the results were statistically significant and the mGCS score was found to be lower in the deceased group. Although our study results are similar to the results of other studies, it suggests that shock status and the presence of difficult-to-diagnose head trauma in traumatized cats may affect the mGCS score and that mGCS should be performed together with ATT scoring, especially in traumatized cats.

In human and veterinary medicine, lactate has been extensively studied in intensive care patients and has been shown to be useful in assessing the prognosis of the disease (Shapiro and Peruzzi 1995, Nguyen et al 2004). Lactate is produced by cells under anaerobic conditions. Hyperlactatemia means an increase in lactate concentration; lactic acidosis is a high lactate concentration accompanied by a decrease in systemic blood pH. Lactic acidosis most commonly occurs as a result of tissue hypoperfusion and hypoxia, which can occur with shock, severe anemia, respiratory problems and hypermetabolic states. Lactic acidosis can also be a result of various drugs/toxins, mitochondrial disorders, and diseases such as sepsis that compromise aerobic energy production and lactate consumption. Hyperlactatemia in humans; It has been associated with increased mortality in many clinical

scenarios including trauma, infection, sepsis and cardiac arrest (Kaplan and Kellum 2008, Kohen et al 2018, Murgia et al 2019). Kohen et al (2018) conducted a study on 302 dogs and 56 cats and found that plasma lactate concentration was higher in the deceased cat group and lower in the surviving cat group, and low venous pH and low partial oxygen pressure were observed in the deceased group.

In our study, plasma lactate concentration was found to be higher in the deceased cat group than that in the surviving cat group, although there was no statistically significant difference, consistent with other studies. In addition, venous pH was found to be lower and partial oxygen pressure was higher in the deceased group. Contrary to the literature, the reason for the higher oxygen values in deceased animals is thought to be due to the severity of trauma and also because oxygen assessments were made from venous blood. Hypoalbuminemia and hypoproteinemia may reflect internal bleeding, the presence of systemic inflammatory response syndrome (SIRS), sepsis, and severe tissue damage, and can potentially lead to edema, acid-base disorders, ascites, pleural effusion, and delayed wound healing (Fish et al 2019, Klainbart et al 2022).

In human and veterinary medicine, hypoalbuminemia and hypoproteinemia are considered important prognostic factors for mortality (Conner 2017, Klainbart et al 2022). In a retrospective study conducted by Klainbart et al (2022) on 72 traumatized cats, albumin and total protein levels were found to be lower in cats that died due to trauma than in those that survived. The albumin and total protein concentrations obtained in our study were found to be lower in cats that died, in line with other studies. The reason for this; We think that it may develop due to the decrease in blood proteins due to blood loss due to trauma, the leakage of plasma proteins into the extravascular space as a result of increased vascular permeability due to trauma, and SIRS, the negative effect on the function of the liver, which is responsible for the production of albumin and other plasma proteins, due to trauma and perfusion disorder, and the interruption of protein production, and the increased destruction of proteins due to the increased metabolic needs of the body after trauma.

Anemia is defined as a decrease in red blood cell mass due to decreased production, increased destruction, or loss of red blood cells (RBCs) (Gonzalez et al 2022). Bleeding due to trauma can be a life-threatening event, especially when it is not controlled or when large amounts of blood are lost in a short time (Foex 1999). In our study, RBC, Hb, and HCT values in the deceased cats were found to be lower than in the surviving group and are parallel to the RBC, Hb, and HCT reference values of other studies (Fish et al 2019, Parlak et al 2022). It is thought that the low RBC, Hb, and HCT values in the deceased group are related to traumatic hemorrhage (internal and external bleeding).

Clinical findings of renal injury in trauma patients are usually not apparent at the initial examination. These findings may not be detected for several hours and require close follow-up after the trauma. Abnormalities such as uroabdomen, uroretroperitoneum, direct renal trauma, or urethral injury can be life-threatening. Urine output, BUN, creatinine, and potassium values should be monitored in all patients with suspected renal injury (Tello 2009). In our study, BUN values were found to be higher in the deceased group than in the surviving group and are similar to the reference values in the retrospective study of Fish et al (2019) on 129 cases. In our study, it is thought that the high BUN levels in cats that died due to trauma are due to the inability to excrete metabolic wastes such as urea due to impaired renal perfusion due to trauma, increased nitrogenous wastes released due to muscle damage due to trauma, and decreased urea excretion from the kidneys due to fluid loss and dehydration caused by shock.

Conclusion

In this study evaluating the prognostic factors determining mortality in traumatized cats, it is thought that ATT scores should be done first when they come to the clinic and that they should be repeated at certain intervals during the treatment process. Because ATT scoring has been seen to be a proven scoring in predicting mortality in many retrospective and prognostic studies evaluating traumatized cats, including our study. In addition, although mGCS scoring is not as good as ATT, it has been seen that it can be used as a representative variable for systemic shock in patients with impaired motor function and consciousness due to perfusion abnormalities. The part we will pay attention to in this scoring is that it should not be forgotten that the presence of head traumas that are difficult to detect and not seen in the first examination may vary in the mGCS evaluation in polytraumatized cats.

We believe that laboratory measurements, especially lactate, BUN, total protein, hematocrit, hemoglobin and partial oxygen pressure, should be performed before starting the treatment protocol in cats admitted to the clinic due to trauma, and these measurements should be repeated several times during the treatment period.

In this study, ATT and mGCS scores, along with hematological and biochemical parameters, were assessed only at the time of initial presentation. Future research should focus on longitudinal assessments of these parameters at multiple time points throughout

the treatment period to further elucidate the prognostic factors associated with mortality in traumatized cats.

Declarations

Competing Interests
The authors did not report any conflict of interest or financial support.

Availability of Data and Materials
The data that support the findings of this study are available on request from the corresponding author.

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Ethical Statement
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Author Contributions
Motivation/Concept: EME, KP, HE; Design: KP/HE; Control/ Supervision: EME/KP; Data Collection and Processing: HE/EME; Analysis and Interpretation: KP; Literature Review: EME/KP; Writing the Article: EME/KP/HE; Critical Review: KP

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