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# Treatment options and prognosis for distal humerus fractures in cats

## Opciones de tratamiento y pronóstico para las fracturas de húmero distal en gatos

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**ABSTRACT**

This study aimed to share clinical experiences on fracture type, treatment options and long-term results of treatment in cats with distal humerus fractures. Within the scope of the study, 11 cats with distal humerus fractures were evaluated. 4 of them were treated with cross pin and 7 of them were treated with plate osteosynthesis. Plate application in the postoperative period gave more successful results. In cases where there is no improvement, elbow joint arthrodesis is recommended before amputation. Distal humerus fractures can be challenging and a perfect technique for this area is not yet possible, but satisfactory results can be achieved despite everything.

**Key words:** Arthrodesis; cats; cross pin; distal humerus fractures; plate application

**RESUMEN**

Este estudio tuvo como objetivo compartir experiencias clínicas sobre el tipo de fractura, las opciones de tratamiento y los resultados a largo plazo del tratamiento en gatos con fracturas de húmero distal. Dentro del alcance del estudio, se evaluaron 11 gatos con fracturas de húmero distal. 4 de ellos fueron tratados con pasador cruzado y 7 de ellos con osteosíntesis con placa. La aplicación de placas en el postoperatorio dio resultados más exitosos. En los casos en los que no hay mejoría, se recomienda la artrodesis de la articulación del codo antes de la amputación. Las fracturas del húmero distal pueden ser un desafío y aún no es posible una técnica perfecta para esta área, pero a pesar de todo se pueden lograr resultados satisfactorios.

**Palabras clave:** Artrodesis; gatos; cross pin; fracturas de húmero distal; aplicación de placas

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## INTRODUCTION

Feline humeral fractures have a special place in small animal practice. The humerus accounts for approximately 4–9% of fractures in cats (*Felis catus*) [1]. The majority of these fractures (75–87%) are in the diaphysis. Condylar fractures of the humerus are much rarer than in dogs, and this is attributed to the fact that the anatomical structure of cats is different from dogs. This difference is due to the fact that in cats the humeral shaft is relatively straighter, the humeral condyles are wider and flatter, and the supratrochlear foramen is absent, whereas in dogs there is a predisposition to structural weakness in the condylar region [1, 2, 3, 4].

Although there are not enough studies on the results of different treatment options for distal humerus fractures in cats as in dogs, in studies comparing cats and dogs, it has been reported that the overall complication rates with the use of plates, screws and external skeletal fixation (ESF) are significantly higher in cats [1, 2, 3, 5, 6, 7].

Thoracic trauma is a condition that should not be neglected in front extremity fractures. Therefore, in these patients, the examination should first begin with airways–respiration–circulation (ABC) evaluation [8, 9].

This study aimed to share clinical experiences on fracture type, treatment options and long-term results of treatment in cats with distal humerus fractures.

## MATERIAL AND METHODS

### Patient selection criteria

Among the cats diagnosed with humerus fractures at Dicle University Veterinary Faculty Animal Hospital between June 2023 and March 2024, those with distal humerus fractures were included. For each case included in the study, gender, age, weight, etiology, treatment method used, postoperative management and subsequent examination findings were recorded on the patient registration forms. Complications were categorized as minor (not requiring treatment or surgery to correct), major (requiring surgery to resolve), and catastrophic (permanent arthrodesis and amputation).

Airways–respiration–circulation (ABC) was evaluated in the cats included in the study during general examination and trauma management. Oxygen support was provided with a mask to those who needed oxygen. Each case was monitored and pulse rate, respiratory rate, $SpO_2$, systolic, diastolic, mean arterial blood pressures and body temperature were measured.

Detailed clinical examination, radiological examination and clinical laboratory tests were performed on all animals included in the study. Complete blood count, serum biochemical analysis, blood lactate concentration and coagulation profiles were determined. Measurements were made using ready-made commercial kits on Mindray® BC-28000 Vet hemogram and Fujifilm NX500 biochemistry devices.

In terms of thoracic trauma, conditions such as the presence of effusion, pneumothorax, diaphragmatic hernia, rib fractures, and wounds on the thorax wall were examined. Oxygen support was continued for cats showing abdominal breathing. In those with effusion and pneumothorax, thoracocentesis was performed and they were subjected to medical treatment before the operation. Medical treatment: tranexamic acid (10 mg·kg$^{-1}$, Transamin® 5% ampoule, Teva, IV), methylprednisolone (20 mg·kg$^{-1}$, Prednol L® 20 mg, IM, Mustafa Nevzat), furasamide (2.5 mg·kg$^{-1}$,IM, Diuril® Vetaş), bronchodilator, amoxicillin+clavulanic acid (Synulox®, Zoetis, Turkey, 8.75 mg·kg$^{-1}$ subcutaneously) and enrofloxacin (Baytril-K® 5%, Bayer, Turkey, 5 mg·kg$^{-1}$, subcutaneously) aurocel bronchodilators (Ventolin™ 2.5 mg) Treatments that varied depending on the animal's condition, such as nebul (GlaxoSmithKline) were applied.

Considering the thoracic trauma, mannitol was preferred as fluid therapy and care was taken to ensure that IV fluid administration did not exceed 10 mg·kg$^{-1}$·h$^{-1}$.

According to clinical examination, TFAST, radiographs and clinical laboratory results, humeral osteosynthesis was decided for suitable cases.

### Surgical procedure

All surgeries were performed by the same team and with the same set used routinely. After xylazine (1 mg·kg$^{-1}$ IV) and ketamine (10 mg·kg$^{-1}$ IV) were given for induction, endotracheal intubation was achieved (with tube number 3–3.5) and then anesthesia was maintained with sevoflurane (Sevorane, Abbot, İstanbul, Türkiye) at 100% $O_2$. Following routine operation preparations, the cat was positioned appropriately and a craniolateral, lateral or craniomedial approach was applied, depending on the location of the fracture. Open reduction was used for plate fixation to the lateral or craniolateral aspect of the humerus. Fixation was achieved with a veterinary plate (2.0 mm; Orthocat, Istanbul Turkey), locking plate (FIG. 1) or cross pin (FIG. 2). In cases where pin was applied, the bandage was kept for 3 weeks.

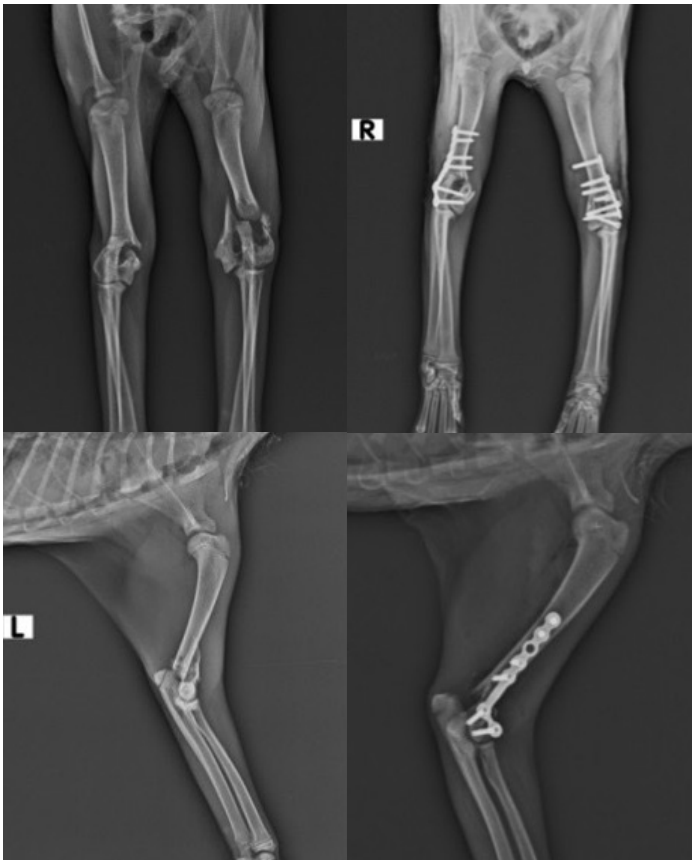


**FIGURE 1. Unilateral and bilateral examples from cases where fracture fixation was achieved with plates**

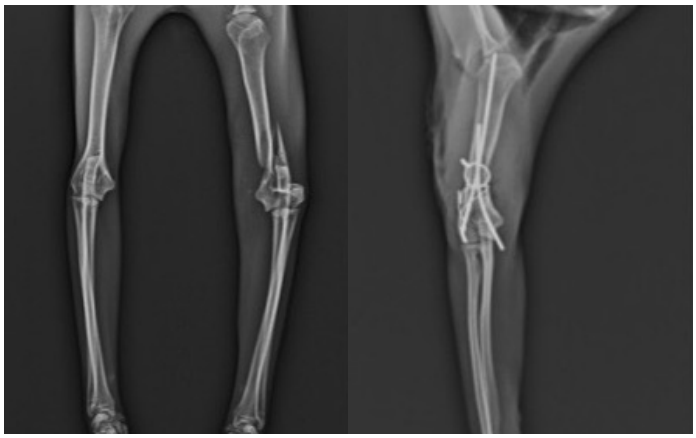

**FIGURE 2. Example of cross pin application cases**

### Postoperative management

They were kept in the intensive care unit immediately after the operation and reanimation was provided there. After the necessary follow-ups, those in good condition were discharged. Cat owners were advised to limit their cats' movements in a narrow area for at least 4 weeks. Fracture healing was based on radiographs. In the radiographic evaluation of fracture healing, the integrity of the cortex, the presence of callus, and the absence of gap between the fragments were taken into consideration. Clinical follow-up was provided by control examinations. During this process, arthrodesis was recommended for those with major complications, while amputation was performed for those with catastrophic complications.

## RESULTS AND DISCUSSION

In this study, 11 cats were evaluated within the scope of the study. 5 of them were Tekir, 3 were British short hair, 2 were mestizo and 1 was a Van cat. All of the cats were old enough to be considered adults and their age ranged from 1 to 4 years (mean 2.34 years). Their weight was between 1 kg and 5 kg (average 3.45). While 7 of the cats were female, 4 were male. It was understood that the cause of fracture in all cases was trauma due to falling from a height, and no open fracture was found in any of the cases.

Diaphyseal humerus fractures are common types of fractures in cats. While this rate is 71%, it has been reported to be 27% in dogs. Condylar fractures are much less common. While these fractures account for only 10% of total fractures in cats, they are 40% in dogs [1, 2, 3, 5]. Findings from many different studies suggest that there is no advantage to choosing a particular fixation system for humeral fractures, so the surgeon's optimal choice for the fracture will be based on his or her own preference and experience [1, 6, 7]. Additionally, in small animal orthopedics, cats and dogs are often considered together. However, cats may sometimes have different anatomy, such as the distal humerus, and this should not be ignored. Beacause, this is not always possible due to anatomical differences, especially in the distal humerus. For this reason, it is necessary to make a decision by taking into account both the location and type of the fracture and the anatomy of the region. In cats, treatment of comminuted fractures of the distal humerus or Salter Harris type I, type II and III fractures is more difficult. Therefore, this study aimed to share clinical experiences regarding fracture type, treatment options, and long-term results of treatment in cats with distal humerus fractures.

As with other fractures, treatment options may vary depending on the direction of the fracture line, whether there is damage to the surrounding soft tissues, or the time that has passed since the fracture. In addition, humeral fractures are also important in terms of thoracic trauma. Distal humerus fractures are more difficult to repair than other fractures of the humerus [1, 3, 6, 10]. Since this study was a clinical study and distal humerus fractures were rare, the cases comprising the study were evaluated together in terms of distal humerus fractures. There were no open fractures among our cases, but soft tissue damage varied between cases. The time since the fracture differed between cases because not all animals could be operated on immediately due to thoracic trauma. While medical treatment and thoracocentesis and other interventions in thorax trauma management were applied, the animal was waited for the general condition to stabilize. These details were ignored within the scope of the study.

Stabilization with external fixation, intramedullary nailing techniques or plate osteosynthesis techniques are used in humerus fractures (11, 12, 13). Additionally, the humerus bone may be suitable for combined techniques such as "tie-in". However, the situation is more serious in the distal humerus. Because both the fracture line and the techniques to be used are limited [14, 15, 16, 17, 18]. In this study, cross pin application was performed in 4 cats, but the results were not good, 3 of them were amputated and elbow joint arthrodesis was performed in 1 of them. But later, a decision was made to amputate (FIG. 3) this animal as well.

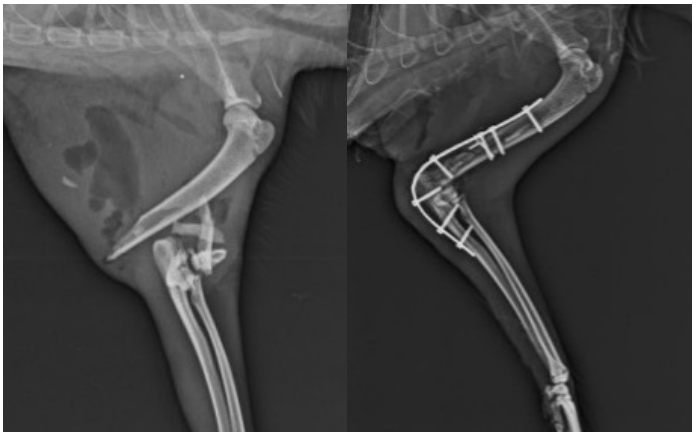

**FIGURE 3. A case of having to be amputated**

After the arthrodesis procedure, a much longer period of immobilization is required compared to fracture repair. For this reason, a procedure such as a plaster bandage is not very desirable due to the complications associated with the bandage. There is no anatomically suitable material to lock the elbow joint. However, pantarsal or pan carpal arthrodesis is easier using a flat or V plate [7]. In this study, arthrodesis was performed in only 2 of the cases where plaque was applied (FIG. 4). In one of the cats that underwent arthrodesis, the plate broke, there was no improvement in the area after repeated surgery, and eventually amputation was performed (TABLE I). In addition, a condition considered functionally and aesthetically important was achieved in cases where arthrodesis was performed on the joint using a locking plate. Patient owners initially worry about amputation. Therefore, if the arthrodesis procedure does not yield a successful result, amputation may be recommended.

**FIGURE 4. A case in which arthrodesis was performed**

***TABLE I***
**A combination of applied techniques and complications**

| | Complications | | | |
|---|---|---|---|---|
| | Minor | Major | Catastrophic | |
| | | | Arthrodesis | Amputated |
| Cross pin (n=4) | | | 1 | 3 |
| Plaque (n=7) | 5 | – | 2 | 1* |

*: It was a cat that underwent arthrodesis.

It may be difficult to determine the incidence of distal humerus fractures in this study, because we are a faculty hospital and we have mostly referred patients that general practitioners or private clinics cannot intervene in, so it was not possible to capture other fractures of the humerus. For this reason, selected cases of distal humerus fracture were given.

In cases of cat forearm fractures and therefore humerus fractures, the thorax should be evaluated for thoracic trauma. It has been reported that effusion is observed at a rate of 60% or more in a cat with a forearm fracture. This figure is quite large and vital. For this reason, additional practices for first aid and thorax emergency should not be neglected (17, 19, 20, 21, 22). In all cases within the scope of this study,) was evaluated first. Oxygenation was supported and the primary goal was to keep the animal alive. Surgeries were performed after the clinical condition was stabilized.

## CONCLUSION

Humerus fractures are known to be less common in cats than in dogs, but distal humerus fractures are more common in cats and fracture stabilization is more difficult due to the anatomical structure. Experience from this study shows that attention should be paid to thorax trauma management in humerus fractures. Secondly, we recommend locking plate osteosynthesis for fracture stabilization. However, if recovery is not possible, arthrodesis should be tried and if the condition is still bad, amputation may be required.

### Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author (BEK).

### Conflict interests statement

The authors declare that they have no conflicting interests.

### Financial Support

This study was supported by Dicle University Scientific Research Projects (DUBAP) Coordination Office (Project no: Veterinary 24.015).

### Ethical approval

All methods and procedures used in this study comply with the guidelines of the Turkiye 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, the patients' owners were informed and their permission to use the date was obtained.

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