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Feline Unilateral Hip Dislocation and Contralateral Limb Fractures: Long-Term Outcomes

Nahit Saylak[1], Berna Ersöz Kanay[1], Sadık Yayla[1], Emine Çatalkaya[1], Semih Altan[2] & Ufuk Kaya[3]

ABSTRACT

***Background*:** Coxofemoral dislocation accompanied by a contralateral long bone fracture is a rare and challenging orthopedic condition in feline patients. It typically resulted from high-rise syndrome, which involves falling from significant heights, and often required complex surgical and postoperative management. While femoral head and neck excision (FHNE) was a widely accepted salvage procedure for coxofemoral luxation, particularly when primary joint reconstruction was not feasible or economically viable, there had been limited information regarding its long-term functional outcomes in cases involving additional orthopedic trauma. In such multifocal injuries, optimal recovery depended not only on surgical precision but also on postoperative rehabilitation, neuromuscular adaptation, and caregiver compliance. The present study aimed to investigate and compare long-term clinical outcomes of FHNE alone and in combination with simultaneous fracture osteosynthesis in cats, using objective clinical data and subjective owner-reported evaluations.

***Materials, Methods & Results*:** This retrospective study reviewed the medical records of 72 cats diagnosed with traumatic unilateral coxofemoral dislocation between 2020 and 2024. Most injuries (82%) were associated with high-rise syndrome. Forty-eight cats (66.6%) that met the inclusion criteria were enrolled. Group I (GI, n = 14) underwent FHNE alone, and Group II (GII, n = 34) received FHNE combined with stabilization of contralateral long bone fractures using intramedullary pins, locking plates, or external fixators. Cats ranged from 1 to 9 years of age and were of both sexes. Follow-up evaluations continued over the long term, including physical examinations, gait observations, and standardized owner interviews. The early complication rate was 42.8% in GI and 17.6% in GII, whereas the total long-term complication rate across both groups was calculated as 25%. Functional outcomes in GII were significantly better during the initial two postoperative weeks ($P < 0.05$). GI cats displayed prolonged disuse of the operated limb, accompanied by moderate-to-severe muscle atrophy. In contrast, GII cats engaged both hind limbs earlier and showed milder atrophy and faster return to normal locomotion. Clinical evaluations confirmed reduced lameness and improved postural balance in GII. Owner feedback was consistent with these findings, indicating higher satisfaction, earlier weight bearing, and more complete recovery in GII.

***Discussion*:** The findings suggest that combining FHNE with concurrent fracture stabilization promotes earlier functional recovery and reduces muscle wasting in cases involving bilateral hindlimb injury. Bilateral limb usage may enhance symmetrical weight distribution, prevent disuse syndrome, and support neuromuscular adaptation during the rehabilitation period. Integrated surgical approaches, especially in polytrauma cases, appear crucial to restoring mobility and quality of life in feline patients. Moreover, strong alignment between clinical assessments and owner perceptions reinforces the value of incorporating subjective quality-of-life indicators in orthopedic outcome evaluations. The study also observed that early postoperative limb use had a positive impact on the overall recovery process. This therapeutic combination may serve as a practical and effective strategy for veterinarians managing multifocal orthopedic injuries in feline trauma patients, particularly those resulting from high-rise syndrome.

Keywords: atrophy, cat, coxofemoral luxation, fracture, long-term FHNE results.

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[1]Department of Surgery, Faculty of Veterinary Medicine, University of Dicle, Diyarbakir, Turkey. [2]Department of Surgery, Faculty of Veterinary Medicine, University of Dokuz Eylul, İzmir, Turkey. [3]Department of Biostatistics, Faculty of Veterinary Medicine, University of Hatay Mustafa Kemal, Hatay, Turkey. CORRESPONDENCE: N. Saylak [nsaylak@gmail.com]. Department of Surgery, Faculty of Veterinary Medicine, University of Dicle. 21280 Diyarbakır, Turkey.

INTRODUCTION

Coxofemoral dislocation is an orthopedic condition in which the femoral head (caput femoris) becomes separated from the acetabulum and displaced in various directions. In animals, 90% of dislocations involve the coxofemoral joint, and they are often accompanied by other orthopedic or systemic injuries [11,16,19]. Treatment options in cats include exercise restriction, analgesia, closed reduction, open reduction with stabilization, femoral head and neck excision (FHNE), and total hip replacement (THR) [12,23]. FHNE is frequently used in cases involving femoral neck fractures, acetabular fractures, coxofemoral dislocation, or capital physeal fractures caused by trauma or degeneration [1,2,24,27]. This technique removes the painful or dysfunctional femoral head and neck, providing a functional pseudarthrosis and pain-free mobility. It is a salvage procedure often used when other treatments have failed, particularly after complex fractures or femoral head necrosis [10,20]. Although outcomes are often reported as satisfactory [14,18], dorsal displacement of the proximal femur remains a concern [17]. Owner-reported outcomes do not always align with objective clinical findings [10]. Reported complications include persistent lameness, muscle atrophy, patellar luxation, sciatic nerve damage, and dorsal femoral displacement [27]. Careful surgical execution and early physiotherapy are key to successful recovery.

The aim of this study was to evaluate the long-term effects of unilateral FHNE performed alone or simultaneously with contralateral long bone fractures in cats with traumatic coxofemoral dislocation.

MATERIALS AND METHODS

Animals

The medical records of cats that underwent femoral head and neck excision (FHNE) surgery due to high-rise syndrome at the Department of Surgery, Dicle University Hospital, between May 2020 and December 2024, were identified and retrospectively reviewed. Data were collected specifically for cats that underwent FHNE surgery and fracture osteosynthesis in the contralateral limb simultaneously with FHNE, in order to evaluate the long-term outcomes of both treatments.

Criteria for inclusion

Cases included in the study were those in which cats presented with high-rise syndrome and, following physical/orthopedic examination, were found to have coxofemoral dislocation, as well as a fracture in any of the long bones of the contralateral limb occurring simultaneously with the dislocation. Only cases where osteosynthesis was performed through surgical intervention and data were available for short-, medium-, and long-term follow-up were included. Exclusion criteria included breed, body weight, sex, diagnosis, anesthesia records, localization of dislocation and fractures, suitability of FHNE surgery as determined by postoperative radiographs, recovery status records from the 1st follow-up, and cases lacking survey data from the owners. A total of 72 cats underwent FHNE surgery and 48 of them met the inclusion criteria. Of these cases, only cases with coxofemoral dislocation (GI n = 14) that underwent FHNE surgery and cases with coxofemoral dislocation and concurrent fractures in any long bone of the contralateral extremity (GII n = 34) that underwent plate osteosynthesis simultaneously with FHNE surgery according to the anatomical shape of bone fracture were examined.

Data collection

The data obtained from medical records, including the clinical signs at the time of admission, the patient's body weight, preoperative lameness assessment, as well as relevant physical/orthopedic examination findings, concomitant orthopedic conditions (fracture in another extremity), non-orthopedic soft tissue injuries, and metabolic diseases, the cause and duration of the dislocation, the presence of concomitant pelvic injuries or conditions (e.g., femoral neck fractures), relevant preoperative radiographic findings, surgical details, postoperative radiographic findings, postoperative management, complications, and follow-up examination details (Figure 1) were analyzed. Postoperative management information included duration of exercise restriction (cage rest) and postoperative antibiotic and NSAID administration. Complications were classified as 2 weeks after the operation, short (5 months), medium-term (9 months) and long-term (13 months) postoperatively; short-, medium- and long-term postoperative complications were subdivided into major and minor complications. Major complications required medical/surgical treatment to resolve, and minor complications did not require medical/surgical treatment to resolve. Follow-up data on complications and claudication were

obtained from the in-hospital medical records of contributing institutions and from telephone interviews by relatives. The date of the last examination and 2-week, short-term (5 months), intermediate-term (9 months), and long-term (13 months) complications recorded by the relatives were recorded [6, 21].

In our study, regarding the grading of lameness, Voss *et al*. [25] a grade was assigned to each case using a 4-point lameness scale as a reference. According to this grade, no lameness was defined as (grade 0); low-grade lameness was defined as barely visible or no lameness but the cat could not jump (grade 1); moderate lameness was defined as clearly visible but the surgically treated limb was used for most steps (grade 2); and high-grade lameness was defined as the cat only touching its toes or not bearing weight on the surgically treated limb (grade 3) [25]. The questionnaire, which must be completed by the cat's relatives in advance, was adapted from previous studies on feline joint disease. A previously used owner telephone questionnaire based on publications was used [16]. Outcome classification was determined as excellent, good, fair or poor based on degree of lameness, requirement for analgesic medication, activity level at time of survey completion or last alive, and owner satisfaction score based on previous publications. The lowest outcome was assigned to cats with criteria in more than one outcome category [12].

Anesthesia, surgery and postoperative evaluations

The data examined showed that the same anesthetic agents were applied to all cases. Before anesthesia, cats in all groups were injected with medetomidine[1] [Domitor® - 80 µg/kg/IM], butomidor[2] [Butomidor® - 0.4 mg/kg/SC] and ketamine[2] [Ketasol® - 5 mg/kg/IM]. Following anesthesia induction, an intubation tube was placed and anesthesia was maintained with isoflurane[3] (1.5-2.5%) [Isoflurane 100 mL]. For postoperative analgesia, Ketamine[2] [Ketasol - 12 mg], Butorphanol[2] [Butomidor - 4.8 mg] and Medetomidine[1] [Domitor - 40 mcg] were added to 100 mL of 0.9% isotonic sodium chloride [5 mL/kg/h, IV] and administered to the patient using an automatic infusion pump during the perioperative period (Veterinary Anesthesia & Analgesia Support Group, 2021). Monitoring of all cases (Veterinary Monitor Device: YSD 16V-vet) was performed throughout the operation. FHNE procedures were performed via a craniolateral approach to the coxofemoral joint in all cases. Each FHNE operation was performed as previously described in both groups [15].The study to evaluate the adequacy of the excision postoperatively, a ventrodorsal view of the pelvis, centered on the extended coxofemoral joints, was taken. Complete excision of the femoral neck without bony prominence at the osteotomy site was deemed sufficient. Postoperative radiological controls were performed, and suitable cases were selected. The surgeries were carried out by 2 different surgeons, and all controls were collected simultaneously by different surgeons.

Statistical analysis

Stata version 15.1[4] [StataCorp] was used for statistical analysis. Descriptive statistics for each variable that was included in the study were calculated and for qualitative and quantitative variables, were presented as "frequency-percentage" and "arithmetic mean ± standard error", respectively. Before performing the statistical analysis, data were examined for normality as parametric test assumptions. A two-way mixed ANOVA for repeated measures was used to test the differences in each variable between group (GI and GII), sampling time (week 2, month 5, month 9 and month 13) and their interaction term. Group and sampling time were included as a fixed factor in all models. Pairwise comparisons were done using a Bonferroni adjustment. $P < 0.05$ was considered as statistical significance level in all analyses.

RESULTS

A total of 72 cats were evaluated and 48 (66%) of them were included in the study. These 72 cats were excluded from the study due to missing data (radiographic, lameness and questionnaire). The distribution of the included cats according to the cause of trauma, anatomical region treated, breed and sex is presented (Table 1). In the study, the gender distribution in GI was 64% male (M = 9; F = 5), while in GII it was 52% male (M = 18/ F = 16). The causes of trauma were 78% fall from height syndrome, 14% traffic accidents and 7% unknown traumas in GI, while in GII it was 82% fall from height syndrome, 11% traffic accidents and 5% unknown traumas. The mean ages at the beginning of the study were determined as GI (14 ± 3 months) and GII (18 ± 8 months). In general, it was determined that the cases in GI did not use the long extremity that had FHNE operation for an average of 10 days (kept it suspended) and started to use it in the advanced postoperative process. On the contrary, it was determined that the cases in GII, who had FHNE and had fracture osteosynthesis applied to the contralateral long extremity, used both legs cautiously. It was determined that the cases in GI adapted to walking with 3 legs in the 1st days after the operation and continued their lives

without any change in their movements and activity, and it was among the data that they used their legs cautiously until the 5th month and lameness was detected. However, it was determined that the cases in GII used their hind legs cautiously immediately after the operation, moved slowly and their activity decreased. In the following days of the study, it was determined in the data that the movements in both groups increased and the cases in the GII group started to step earlier and also started to use both hind limbs. In the postoperative period, it was recorded that in the GII cases, due to the presence of soft tissue trauma, the 1st 2 weeks of check-ups were done more frequently than in the GI and the relatives of the patients were more interested. In the postoperative check-up days, a significant difference was found between the groups in the lameness examination data at the 2nd week (Figure 1) and 5th month ($P < 0.05$). On the control days within the group, there was a significant difference in GI between the 2nd week and the 5th, 9th and 13th months, and between the 5th month and the 9th and 13th months ($P < 0.05$). In GII, a significant difference was found between the 2nd week and the 5th, 9th and 13th months ($P < 0.05$). When all control days were considered, it was determined that the lameness degrees were generally higher in GII (2nd week, 5th month, 9th month and 12th month) than in GI. According to the results of the questionnaires examined by the relatives of the patients on the same control days of the study; there was a significant difference between the groups at the 2nd week, 9th month and 13th month ($P < 0.05$) [Figure 2], while no significant difference was found between the 2 groups in the 5th month data ($P > 0.05$). On the control days within the group, there was a significant difference between the 2nd week and the 5th, 9th and 13th months in both GI and GII ($P < 0.05$) [Figure 3].

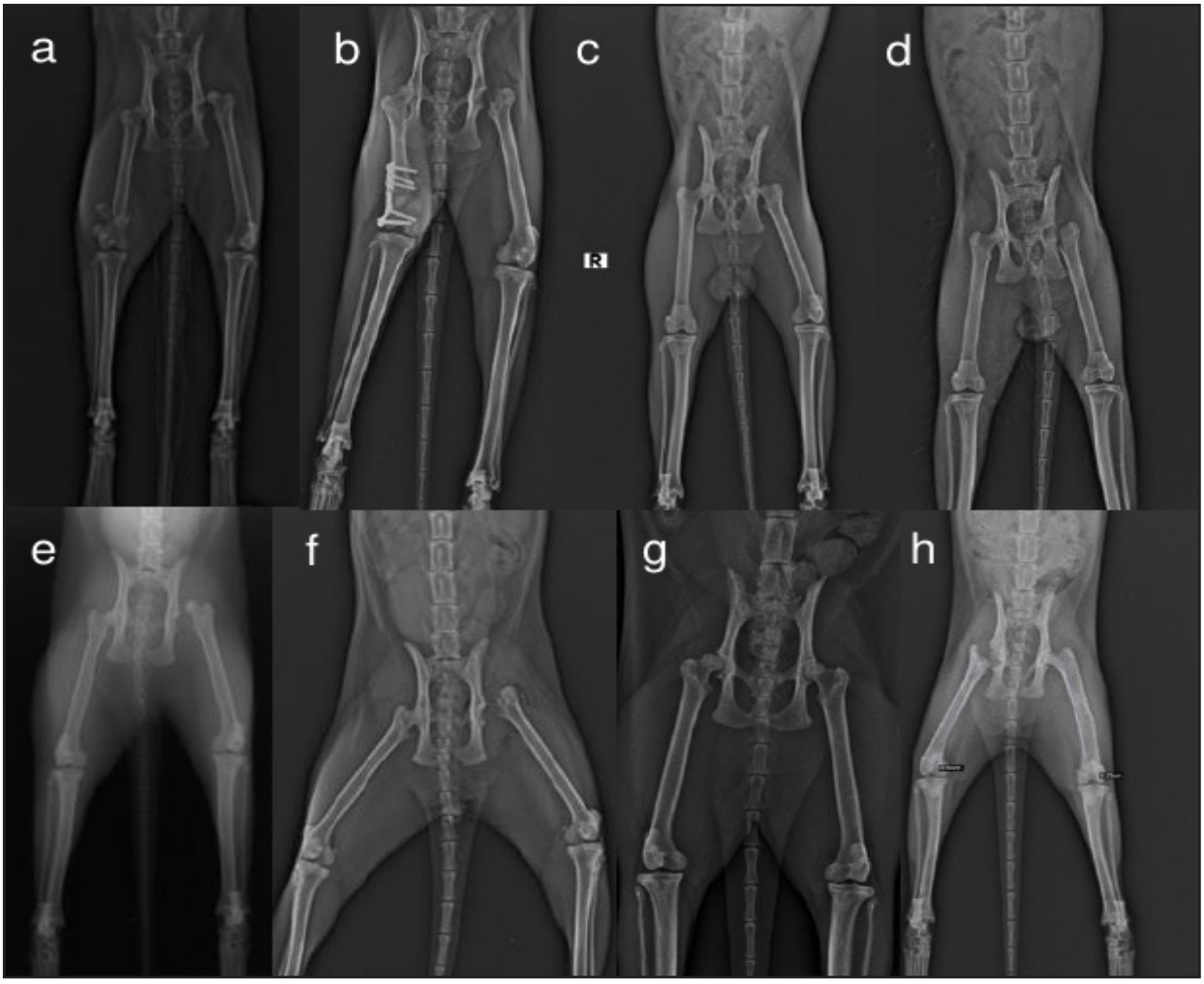

Figure 1. Radiographic images of some cases of operations performed. a-b: Coxofemoral dislocation with distal femur fracture in the contralateral long extremity: pre-operative and post-operative 2nd week view of the same case. c-d: Preoperative and postoperative radiology of the same case for unilateral dislocation. e-f: Preoperative radiology of unilateral coxofemoral dislocation directed proximally and postoperative image of the same case with ongoing complications. g-h: Image of unilateral dislocation and postoperatively, the same case, although the cutting location of the bone was not very suitable, there was no problem with the clinical symptoms.

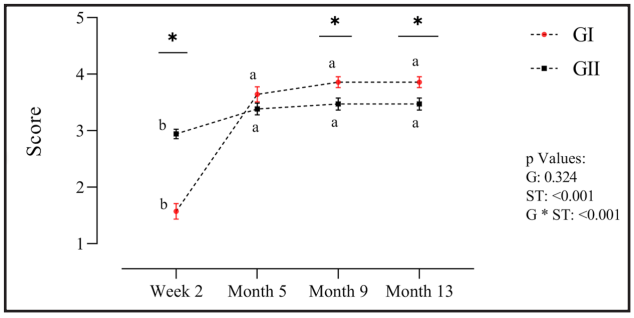

Figure 2. Lameness score of the groups. [a,b,c]Lower case letters in each group indicate differences between times ($P < 0.05$). *Indicates the difference between groups ($P < 0.05$). G: Group. ST: Sampling time.

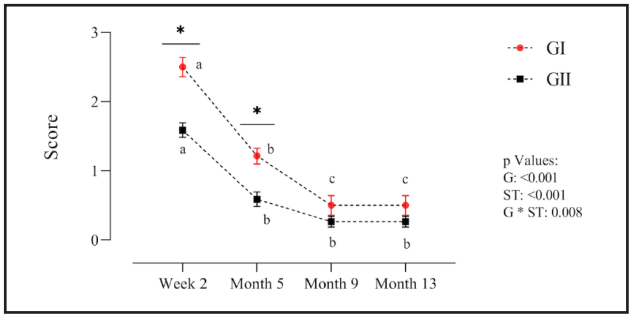

Figure 3. Satisfaction of Pet Owners. [a,b,c]Lower case letters in each group indicate differences between times ($P < 0.05$). *Indicates the difference between groups ($P < 0.05$). G: Group. ST: Sampling time.

Table 1. Detailed information about the operated cats.

			FHNE (n=14)	FHNE+Oseosenetez (n=34)
Cause of trauma	High-rise syndrome		11	28
	Traffic accident		2	4
	Unknown cause		1	2
Medical History	Left		5	11
	Right		9	23
	The long bone of the extremity	Femur	-	18
		Tibia	-	13
		Tarsal Joint	-	2
		Phalanx	-	1
	Soft tissue damage		3	28
Breed / Sex	British Shorthair	Male	2	2
		Female	-	3
	Tabby	Male	3	5
		Female	1	4
	Scottish Fold	Male	3	4
		Female	2	6
	Persian	Male	-	4
		Female	1	1
	Hybrid	Male	1	3
		Female	1	2

Complications

Minor complications on the control days of the study; No problems were detected in GI in 2 cases in the 2nd week, 1 case in the 5th month and in the later days of the study in the 9th and 13th months, and no major complications were detected in 3 cases in the 2nd week and in the 5th, 9th and 13th months. Therefore, the minor and major complication rates in GI were determined as 42%. In GII, minor complications were not detected in 3 cases in the 2nd week, 2 cases in the 5th month, and in the later days of the study, in the 9th and 13th months. As for major complications, no problems were encountered in 1 case in the 2nd week, 6 cases in the 5th month, and on the other days of the study. Therefore, the minor and major complication rates in GII were determined as 17.6%. In the 5th, 9th and 13th months of the study, these complications improved tolerable values. However, in the patient relatives' surveys, it was determined that these complications were noticed only in 1 case in GI and 3 cases in GII. In general, it was seen in the data that all cases in both groups improved tolerable values. According to the entire study data,

minor or major complications were detected in both groups at a rate of 25%.

DISCUSSION

This clinical retrospective study demonstrates that the long-term results of the FHNE operation in the treatment of fractures of the contralateral long extremity with only unilateral coxofemoral dislocation or unilateral dislocation simultaneously with contralateral long extremity are good to excellent according to the clinical lameness score and the results of the patient's relatives' questionnaires [18,27], using the extremity early in the days following the operation may reduce the complication of muscle atrophy [7,8], As in many other studies, in our study, GII was determined as a result of determining the statistically significant difference from GI at the 2nd week. According to the results of the study, there was a significant difference between the clinical lameness scores of the cats with only unilateral coxofemoral dislocation treatment (n = 14) and the controls performed up to the 2nd week according to the patient's relative questionnaires (evaluation was made based on the 2nd week), between the cats with simultaneous unilateral coxofemoral dislocation and the cats (n = 34) with simultaneous unilateral dislocation and any osteosynthesis applied to the contralateral long extremity (GII). When the evaluations were examined, it was clearly seen that the cats in GI for the 1st 2 weeks used the leg that had undergone FHNE operation very rarely until the 10th day, kept it in a sling and the leg atrophied. It was determined that the cases in GII used both legs very little and cautiously, which we thought was due to the operation of the contralateral leg. Therefore, the atrophy in the leg was less severe than in GI and was not seen in some cases. We believe that the reason for the significant difference detected in the lameness controls performed in the 5th month with the same data is that the cats in GI did not use their legs in the days following the operation and the cats in GII started to use their legs immediately after the operation. No significant difference was detected between the clinical lameness data on the other control days (9th and 13th months). We believe that the reason for this is that although atrophy continued in GI and GII, lameness decreased because the cats adapted to this situation. According to the results of a study in which a total of 127 dogs underwent FHNE surgery; 50% of the dogs and 82% of 66 dogs in another study experienced muscle atrophy after FHNE surgery. This is a clinically significant finding because it is stated that the study was long-term and the dogs were measured an average of 2.7 years after surgery. Therefore, muscle atrophy seems to be a long-term consequence. It is stated that atrophied muscles in and around the operation area may be a result of chronically reduced range of motion and weight-bearing capacity of the same extremity [9,18]. In the study, 42% of GI and 17.6% of GII developed varying degrees of muscle atrophy, while different results were obtained from literature studies in this respect, it is similar to other studies in terms of the long-term continuation of muscle atrophy. In addition, we think that the main reason for the variability of muscle atrophy between the 2 groups in the study is that this difference arose due to the early and cautious movements of the cases in GII. Similarly, in our study, it was striking that even very small degrees were considered atrophic in the evaluations of muscle atrophy and that these muscle atrophies were detected even in the final evaluation. Complications identified in previous studies of feline FHNE operations include femoral caudodorsal malposition, limb shortening, muscle atrophy, decreased range of motion, and pain during passive motion [3,22]. In 2 of the cases in the GI of the present study, proximal orientation of the femur, different degrees of muscle atrophy and shortening of the extremity were determined in all cases during the controls. However, among the complications in GII, only 1 case of proximal displacement of the femur was detected, and all other complications were complications related to the implant in the contralateral extremity. In pet animal practice, rehabilitation practices after FHNE surgery are generally accepted [7,8] This is recommended by the clinician and the patient's relatives if they are reluctant to accept or continue due to adaptation problems that may be encountered in cats [3]. In the controls performed in the study, only 3 out of 48 cases applied the rehabilitations recommended in terms of physical therapy, while the others were affected by the stitches in the incision line or rejected due to the reaction of the patient during the application, and the reluctance of the relatives of the patients in this regard was

similar to previous studies. In these operations, the fact that the displacement of the proximal femur was seen more in the GI group despite the small number of cases in the group suggested that it may be due to the unbalanced force application after the FHNE operation. Because it is stated in the survey data that all cases in GII moved slowly and that while using both legs cautiously, their movements generally decreased in the 1st weeks and increased rapidly in the following days. In addition, muscle atrophy was less in GI than in GII, and it was thought that the main reason for this may be the rejection of the rehabilitation applications recommended after the surgery by the relatives of the patients and the early movement of the cases in the GII group, which received applications on both posterior extremities, to meet their general needs. These clinical results show that rehabilitation and early movement after FHNE operations can reduce the severity of muscle atrophy.

Clinical outcomes of FHNEs in cats are reported to be satisfactory to good in some studies [18], however, another study noted that these clinical results were inconsistent due to concern about dorsal displacement of the affected femur [17]. In our study, the clinical results of all cases in GI and GII were satisfactory to good, but in some cases, when radiographs taken due to implant complications were compared, it was seen that clinical signs and radiographic signs did not match. Although it was seen in a few cases that clinical signs and radiographic signs of FHNE operation in cats were inconsistent, we think that more studies are needed due to lack of data. Clarke and Bennett [5] stated in their study that the assessment made using an outcome measurement questionnaire filled out by the owner is comparable to objective measurements in determining lifestyle and mobility changes [5]. Furthermore, an owner-completed questionnaire was indicated as a practical alternative to objective assessment of functional outcome after carpal and tarsal arthrodesis and surgical stabilization of sacroiliac dislocations in cats [4,13]. However, our study showed that the results of the questionnaire modified by the owners were inconsistent with the clinical results. In addition to the fact that the questionnaire results and clinical results in both groups were different, it was thought that the relatives of the patients ignored or misinterpreted the clinical data because they were more optimistic about recovery. According to the data of a study conducted by Yap *et al*. [27], when the owner evaluation and follow-up veterinary examinations of 15 cats were examined, muscle atrophy was found in 7 of 15 cats and pain during passive movement in 4 of 15; however, 100% of the owners stated that the result of the procedure was satisfactory [27] showed similar results with the study, so it was concluded that the survey results of the study may not be consistent. In similar studies, some of the changes in objective outcome assessment reported in cats after FHNE operation were caudodorsal malposition of the femur, limb shortening, muscle atrophy, decreased range of motion, and pain with passive movement [17,18]. The clinical significance of femoral malposition after FHNE is unclear [17]. In a large retrospective study of FHNE in dogs and cats, all cats returned for physical examination 4 to 6 weeks after FHNE had moderate muscle atrophy and variably reduced range of motion of the affected joint [18]. Despite this, all cats evaluated were reported to be using the affected limb at the time of evaluation and had minimal or no obvious lameness [18]. In our study, as in other studies, shortening of the extremities, muscle atrophy, decreased range of motion and signs of pain with passive movement were determined in GI, but from these data, muscle atrophy was more severe than in the cats in GII group. In addition, we think that the significant difference between lameness scores at 2 weeks and 5 months is due to the faster recovery in this group. Despite this, it was included in the data that the affected extremity was used during the evaluation of all cats in both groups and that there was minimal or no significant lameness.

Winders *et al*. [26] reported that there was no significant difference between the craniolateral and ventral approaches in their cadaver study in dogs. In the design of the study, all cases had preoperative and postoperative radiographs and 2nd week radiographs, however, radiographs were missing in the later control days of the study. Therefore, the study evaluated radiographically the first 2 weeks. Craniolateral approach was applied in all cases and no intolerable or operative problems were found in the control radiographs. It was thought that the relatives of the patients did not want radiographic controls due to the improvement of the cases with the clinical and questionnaire controls or that there may be a lack of data due to the aggressiveness of the cats. A shortcoming of this study is the

lack of long-term radiographs. In this respect, previous studies suggest that a questionnaire filled out by the patient's relative is a practical alternative to objective assessment of functional outcome after carpal and tarsal arthrodesis and surgical stabilization of sacroiliac dislocations in cats [4,13] reported, however, the long-term results of the study are different from the clinical examinations and patient relative surveys, and we believe that further studies on this subject may yield interesting results.

CONCLUSIONS

In conclusion, when the findings are evaluated together, it can be seen that although there is a decrease in the general activities and movements of the case in the 1st 2 weeks in the osteosynthesis treatments performed simultaneously with the FHNE operation in contralateral long extremity fractures, muscle atrophy due to early use is less in the leg that underwent the FHNE operation, therefore, performing the contralateral fracture with coxofemoral dislocation together with osteosyntheses can contribute positively to the postoperative recovery process. According to the results of the present study; Among the complications that occur after the FHNE salvage operation, the proximal femur's dorsal orientation is seen more in GI than in GII, although the number of cases is less, suggesting that this complication may actually be due to exposure to uncontrolled and excessive forces. In clinical practice, it is an easy and cheap salvage operation and it can be applied together with contralateral long extremity fractures, and in clinical examination, it was seen that the patients can comfortably continue their lives and easily adapt to the pseudo-joint that was formed.

MANUFACTURERS

[1]Orion Pharma. Espoo, Finland.

[2]Richter-Pharma, Austria.

[3]Adeka İlaç. Istanbul, Turkey.

[4]StataCorp. College Station, TX, USA.

Ethical approval. This study protocol was approved by the Dicle University Health Sciences Application and Research Center Animal Experiments Local Ethics Committee (Approval number: 27/02/2025-15-02).

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