Kafkas Univ Vet Fak Derg
26 (6): 817-821, 2020
DOI: 10.9775/kvfd.2020.24295

Kafkas Universitesi Veteriner Fakultesi Dergisi
ISSN: 1300-6045 e-ISSN: 1309-2251
Journal Home-Page: http://vetdergikafkas.org
Online Submission: http://submit.vetdergikafkas.org

Case Report

Treatment of Pathological Fractures in Two Lion Cubs (Panthera leo) with Nutritional Secondary Hyperparathyroidsm

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Article ID: KVFD-2020-24295 Received: 08.04.2020 Accepted: 12.10.2020 Published Online: 13.10.2020

How to Cite This Article

Kurt T, Altundağ Y, Özsoy S: Treatment of pathological fractures in two lion cubs *(Panthera leo)* with nutritional secondary hyperparathyroidsm. *Kafkas Univ Vet Fak Derg,* 26 (6): 817-821, 2020. DOI: 10.9775/kvfd.2020.24295

Abstract

Secondary nutritional hyperparathyroidism (NSH) is a metabolic disease characterized by the symptoms such as lameness, constipation, lordosis, and pathological fractures resulting from Ca and P imbalance. A five months old captive-bred two lion cubs were presented with pain in the whole body, reluctance to move, and growth retardation with no history of trauma. Radiographs revealed generalized osteopenia, multiple fractures of all limbs, and lordosis of the caudal vertebrae. Some of these fractures were nonunion. Based on radiographic findings and a history of an exclusive chicken liver diet and goat milk since weaning (after 1 month age), a diagnosis of nutritional secondary hyperparathyroidism was made. The diet was changed to a portion of commercial kitten food, vitamin D supplements, goat milk. Operative interventions were performed to repair the fractured bones and for those which were not suitable for operation, bandage was applied. Cubs were given cage rest for 8 weeks. At the end of these processes, patients were discharged walkable.

Keywords: *Lion cubs, NSH, Pathological fractures, Nutritional seconder hyperparathyroidsm, External fixation*

Nutrisyonel Sekonder Hiperparatiroidizmli İki Yavru Aslanda Patolojik Kırıkların Tedavisi

Öz

Nutrisyonel sekonder hiperparatiroidizm (NSH), Ca ve P dengesizliğine bağlı topallık, konstipasyon, lordoz ve patolojik kemik kırıkları gibi semptomlarla karakterize olan bir hastalıktır. Bu raporun materyalini oluşturan beş aylık iki aslan yavrusu, travma öyküsü olmaksızın tüm vücutta ağrı, hareket etme isteksizliği ve büyüme geriliği ile kliniğimize başvurmuştur. Radyografilerinde genel osteopeni, tüm uzuvlarda çok sayıda kırık ve kaudal omurlarda lordoz görülmüştür. Radyografik bulgulara ve sütten kesildikten (1 aylıktan sonra) bu yana tavuk karaciğeri ve keçi sütünden oluşan bir diyetle beslenme hikayesine dayanarak nutrisyonel sekonder hiperparatiroidizm teşhisi konulmuştur. Diyet; ticari bir yavru kedi maması, D vitamin takviyesi, keçi sütü olarak değiştirilmiştir. Hastaların kırıkları için operatif müdahaleler gerçekleştirilmiş, operasyona uygun olmayan kırıklar için bandaj uygulamaları yapılmıştır. Yavrulara 8 hafta boyunca kafes istirahati uygulanmıştır. Bu işlemlerin sonunda hastalar yürüyebilir şekilde taburcu edilmiştir.

Anahtar sözcükler: *Yavru aslan, NSH, Patolojik kırık, Nutrisyonel Sekonder Hiperparatiroidizm, Eksternal fiksasyon*

INTRODUCTION

Nutritional secondary hyperparathyroidism (NSH) is a metabolic disease associated with malnutrition. The affected animals were generally fed with diets such as meat and organ tissue, containing excess phosphate, insufficient calcium, or both [1,2]. Since balanced commercial foods can be easily reached today, nutrition-related diseases are less common. In this disease, bone production is normal but osteopenia results from excessive bone resorption [2,3]. Normal skeletal growth needs Ca:P of 1:1 to 1:2 but the red meat-based diet contains calcium and phosphorus in the ratio of 1:10 (horse meat) to 1:50 (chicken liver) [4]. Even if milk is added to the diet, the calcium content of the meat and milk diet is insufficient for bone development. The imbalance induces hypocalcemia, which increases the secretion of PTH. Increased parathyroid activity tends to normalize blood calcium and inorganic phosphate concentrations by promoting mineral resorption from bone. Also, hyperparathyroidism improves calcium absorption

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from the intestine and facilitates renal phosphate excretion and calcium retention. However, a long-term unbalanced diet sustains the hyperparathyroidism state and causes progressive skeletal demineralization and consequent clinical signs [2,3]. Clinical signs in young animals are more severe than in adult ones and include; lameness, reluctance to move, muscular or skeletal pain, generalized osteopenia, a predisposition to fractures, and rarely seizures that have been documented in some literatures [3-5]. Typical radiographical signs of osteopenia include generalized decreased bone opacity, thinned cortices, and trabeculation. Pathological fractures, spinal curvature changes, and pelvic deformation are often a sequel to longstanding osteopenia. A double cortical line is frequently seen in humans with various forms of osteopenia but is a rare finding in small animals [4,5]. In this case report, it was aimed to improve the health of 2 lion cubs with pathological fractures due to NSH by diet regulation, UV-B application and operative interventions together.

CASE HISTORY

This report; Republic of Turkey Ministry of Agriculture and Forestry General Directorate of Nature Protection and National Parks has been prepared with the permits dated 23.07.2020 and numbered 26137614. Five months old captive-bred male and female two lion cubs were presented with pain in the whole body, reluctance to move, and growth retardation with no history of trauma. These symptoms were noticed 45 days before they came to our hospital. In female patient, femoral and tibial fracture was detected in another clinic and operated with intramedullary grooved pin. In male patient, only femoral fracture was detected and operated with intramedullary Steinmann pins.

However, the symptoms worsened and they were finally admitted to our hospital. According to the anamnesis, the cubs were weaned at the age of 1 month and fed only with chicken liver and goat milk without supplementation of calcium and vitamins after weaning. On physical examination, lordosis, limb fractures, and dehydration were detected in both patients. During the musculoskeletal examination using palpation, pain reaction of the patients was observed. Therefore, it was noted that patients felt pain everytime they move and turned to their aching areas. Hematological and biochemical parameters of the patients were examined and evaluated normal at presentation *(Table 1, Table 2)*. Parathormon (PTH) and Vit D levels of the female patient were high at presentation while the levels were normal in male patient *(Table 3)*.

Multiple radiographs of the whole body and extremities were made under sedation using xylazine (Ksilazol 20 mg/mL, Provet, Turkey) at a dose of 2 mg/kg intramuscularly [9]. As a result of radiographic examinations, it was observed that in both patients had non-union problem in the

Table 1. *Hematological values of female and male lion cubs at presentation*

Parameters	Results		Reference Values
	Female	Male	
RBC M/µL	6.61	7.70	3.8-11.7 (M) [6] 3.8-10.0 (F) [6]
HCT %	28.6	36.4	24.8-54.0 [6]
HGB g/dL	9.9	11.6	4.9-23.0 [6]
MCV fL	43.3	47.3	29.9-76.0 (M) [6] 21.4-64.0 (F) [6]
MCH pg	15.0	15.1	11.2-27.2 (M) [6] 7.2-22.0 (F) [6]
MCHC g/dL	34.6	31.9	20.4-42.8 (M) [6] 20.5-49.7 (F) [6]
RDW %	25.6	25.5	
RETIC %	0.2	0.1	0-0.6
WBC K/µL	12.69	15.63	4.7-31.2 [6]
NEU%	50.9	70.5	45-64
LYM%	41.8	24.1	27-36
MONO%	6.8	4.4	0-5
EOS%	0.1	0.1	0-4
BASO%	0.4	0.9	0-1
NEU K/µL	6.46	11.02	2.30-10.29 [6]
LYM	5.31	3.77	0.92-6.88 [6]
MONO K/µL	0.86	0.69	0.05-0.67 [6]
EOS K/µL	0.01	0.01	0-0.8
BASO K/µL	0.05	0.14	0-0.2
PLT K/µL	213	266	300-800
MPV fL	14.0	14.0	12-18

Table 2. *Serum biochemical panel of female and male lion cubs at presentation*

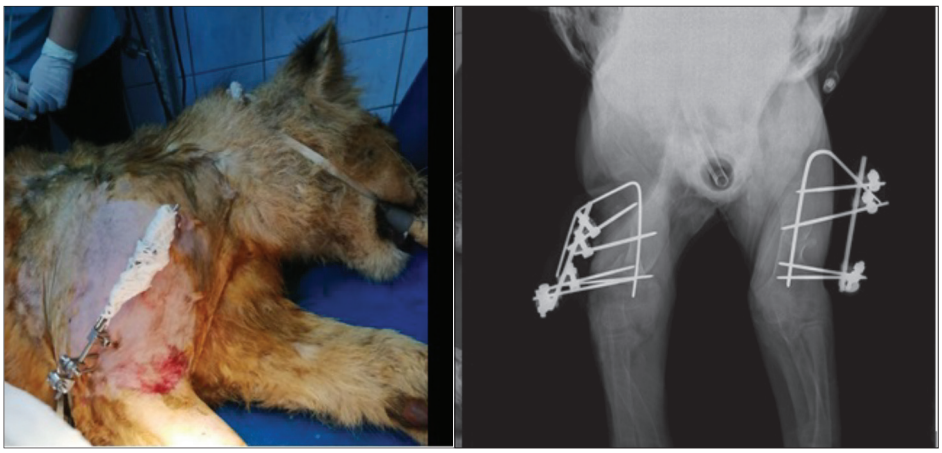
Parameters	Results		Reference Values
	Female	Male	
GLU mg/dL	188	168	60-120 [7]
CREA mg/dL	0.3	0.4	53-327 [6]
BUN mg/dL	17	18	4.28-29.3 [6]
BUN/CREA	53	48	
PHOS mg/dL	5.1	5.3	3.0-6.1 [7]
CA mg/dL	8.6	9.7	8.7-11.7 [7]
TP g/dL	7.3	7.0	5.3-9.7 [6]
ALB g/dL	3.4	3.2	1.9-5.6 [6]
GLOB g/dL	3.9	3.8	1.9-5.7 [6]
ALB/GLOB	0.9	0.9	
ALT U/L	66	54	25-97 [7]
AST U/L	87	35	7-38 [7]
ALKP U/L	125	250	16-355 [6]
TBIL mg/dL	0.6	0.5	0-0.1 [7]
CHOL mg/dL	162	119	90.1-255.2 (M) [6] 91.2-293.9 (F) [6]

Table 3. *Presentation and after treatment results of blood serum values in lion cubs*

Parameters	Presentation Results		30 Days After Treatment Results		Reference Values
	Female	Male	Female	Male	
PTH	0.4 pm/mL	0.0 pm/mL	0.0 pm/mL	0.1 pm/mL	0-1.089 [8]
Vit D	111.0 ng/mL	70.0 ng/mL	12 ng/mL	12.4 ng/mL	26-68 [8]
Ca	9.4 mg/dL	8.5mg/dL	7.6 mg/dL	10.6 mg/dL	8.7-11.7 [7]
P	6.5 mg/dL	6.5mg/dL	4.9 mg/dL	5.6 mg/dL	3.0-6.1 [7]

Fig 1. Generalized osteopenia and lumbar lordosis in male cub

Fig 2. After operation of humeral fracture with Kirschner- Ehmer apparatus in male lion cub



bones due to lack of stabilization, generalized osteopenia *(Fig.1)*. Bilateral humeral, femoral, and antebrachium fractures and lordosis in lumbal spines were detected in the male patient. Besides these, bilateral antebrachium fractures were detected in the female patient. On the basis of nutritional plan, clinical findings and radiographic examination, a diagnosis of NSH was deduced. First, the diet of patients was changed. Quality cat food, goat milk, vitamin D at the dose of 0.05 µg/kg PO [4], chicken neck, and egg were added to the diet. The area of lion cubs was restricted because the movement of patients was painful. Meloxicam 0.1 mg/kg (Meloxicam, BaVet, Turkey) were used for 5 days. Cage conditions were fixed and a UV-B lamp (red light 250w) was placed and used for 6 h per day. Vitamin D, helps calcium and phosphorus absorption from the intestines. It is obtained either by intestinal absorption after food intake or by the synthesis of Vit D3 by exposure to UV-B in the skin [10]. A thick layer of straw was used as

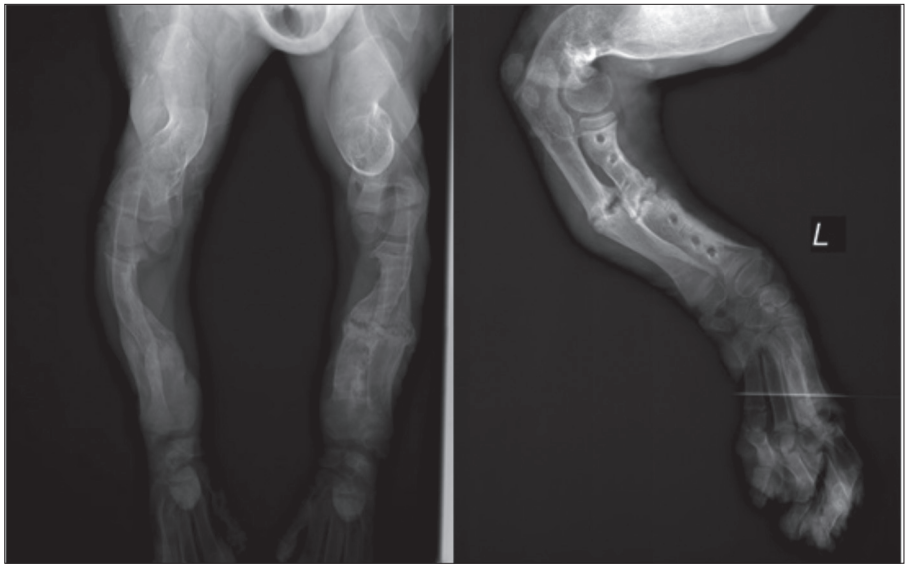


Fig 3. Bilateral forelimb radiograph of female lion cub. Patological fracture of both antebrachium was detected. Callus was identified. Medio-lateral radiograph of left antbrachium following removal of Kirschner-Ehmer fixator (female)

a base, because patients could not walk. As the fractures were old, only to the non-union ones were operated. Patients were sedated with xylazine then, anesthetized with propofol (Propofol-Lipuro 1%, B. Braun, Germany) at a dose of 2 mg/kg intravenously. The patient was intubated and followed by inhalation anesthesia (isofluorone 3%) [11]. The areas to be operated were shaved widely and disinfected with alcohol (70%), then with povidone-iodine (10% ADEKA, Turkey). Bilateral humeral closed technique of osteosynthesis with Kirschner- Ehmer apparatus was performed and the left tibia was bandaged for male patient. The same technique was performed for female patient's right antebrachium. The incision was not made in this technique *(Fig. 2, Fig. 3)*. After the operation, povidone-iodine was applied to the pin bottoms. Ceftriaxone sodium 25-50 mg/kg (Novosef, ZENTIVA, Czech Republic) and meloxicam 0.1 mg/kg were used postoperative for 5 days. Bandages were renewed every 7 days. External fixations materials and bandages were removed together after 45 days. In this process, they were given cage rest for 8 weeks. Last, of all patients were discharged walkable.

DISCUSSION

Despite the widespread use of commercially formulated pet diets, owners sometimes still prefer non-commercial diets, often without taking into account the specific dietary requirements of their pet, thus increasing the risks for health problems such as nutritional bone diseases. The authors believe that NSH is a common disease in captive species of lions associated with nutritional problems [4]. The cubs described in this report were weaned at 1 month and chicken livers and goat milk were added to their diet. The symptoms started at 3.5 months, whereas the cubs were completely dependent on the mother until 3 months of age, and should be weaned at 6-8 months [12]. Normal skeletal growth needs Ca:P of 1:1 to 1:2 while this diet contains calcium and phosphorus in the ratio of 1:50. Kittens in pioneering experiments fed only with red meat began to show locomotory disturbances after 41 days [5]. In thıs case symptoms developed within 2 months of weaning. NSH results from chronic hypocalcemia due to a continuous diet with low calcium. This causes excessive absorption of calcium from the bones, which makes the bones more fragile and disrupts the bone structure [13,14]. Persistently decreased calcium intake lead to chronic parathyroid stimulation, with increased parathyroid hormone secretion in these patients [4]. As a result of these compensatory mechanisms, blood Ca [2,15] and phosphorus levels are reported to be normal or decreased, blood PTH level and vitamin D level increased in patients with NSH [16]. In this case report, blood samples were collected from the patients on the first day, and on the 30th day after treatment and, Ca, PTH, vitamin D and P were measured *(Table 3)*. There is no specific blood result suggestive of NSH. Since the case was delayed, Ca levels were normal in the blood test before treatment. But with clinical examination results, radiographic findings and anamnesis, potentiated the diagnosis towards NSH. In the blood test 30 days after the treatment, Ca and P values were within normal limits in both patients. PTH and Ca levels were increased and P and Vit D levels were decreased. In the female lion cub, PTH, Ca, P and vit D levels decreased compared to the initial state. Normally enough Vit D synthesis occurs when exposed to sunlight for a sufficient period of time [17,18]. Hypovitaminosis D is formed as a result of deficiencies in diet and low exposure to sunlight of animals. In case of vitamin D deficiencies, endogenous vitamin D production is triggered by UV lamps. There is no information about the use of UV-B lamp in the studies conducted on lions. In our study, the bony development of animals was indirectly supported by the use of UV-B lamp for offspring.

Radiographically, reduced bone opacity, pathological fractures and thin cortices are sufficient to define osteopenia [4]. Our patients have multiple pathological fractures

without trauma history. Intramedullary pin application [19] external fixation [20] and plate osteosynthesis [21,22] are used for fracture treatment in wild animals [23]. In this case, external fixation with K-wires was preferred because of shortening anesthesia time, minimal tissue trauma, and easy postoperative care. Only pin-bottom infection was observed as postoperative complications and this situation was easily controlled. There was no study on the operative treatment of pathological fractures with NSH in cubs [4,5]. Pain control was achieved with intermittent use of meloxicam. With cage rest, the patient was followed for a long time. Despite spinal deformites, urination and defecation problems were not observed in patients, and at the end of the treatment, pain stress decreased and they became able to walk. Having a positive result even in such a chronic case may be a ray of hope for other patients in similar situations who are recommended euthanasia.

As a result, NSH is a preventable condition with a balanced diet and early diagnosis.

Conflict of Interest

The authors report no conflicts of interest.

Author Contributions

The authors alone are responsible for the content and writing of this case report.

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