



LEGG-CALVÉ-PERTHES DISEASE IN CLINICAL CASE STUDIES IN DOGS

Renáta Szabóová, Csilla Bajczer

Department of Biology and Physiology, University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, 041 81 Košice
Slovakia

renata.szaboova@uvlf.sk

ABSTRACT

Legg-Calvé-Perthes disease (LCPD) is a degenerative disorder of the femoral head bone with a genetic basis which generally occurs in predisposed small dog breeds (up to 12 kg) at a young age (4–10 months). The aim of this study was to present an overview of this disease, the most common clinical symptoms and to describe methods of diagnosis and therapy of LCPD in dogs. This involved a follow-up of patients, dogs (n = 43; 20 males and 23 females) brought to the veterinary clinic in Hungary with suspicion of LCPD, where they were subjected to clinical, orthopaedic and radiographic examination and then to the most suitable conservative or surgical treatment. The most characteristic clinical symptom – lameness – expressed by lameness grade (from 1 to 5), was monitored in all patients, especially those with grade 4 (n = 26). Additional clinical symptoms, such as response to manipulation (n = 42), pain on palpation (n = 33), weight-bearing (n = 2), muscle atrophy (n = 17) and crepitation (n = 24), were checked in the dogs. The prevalence of the

unilateral form of LCPD in the pelvic limbs was observed in 38 patients (88.37 %) and the bilateral LCPD form appeared in 5 patients (11.63 %). Based on the Ljunggren's score the degree of hip joint damage was observed in most LCPD patients with score 4 (n = 22; 51.10 %). Following the diagnosis, it was necessary to decide on the therapy, conservative or surgical (ostectomy), with elimination of painful symptoms and subsequent long-term postoperative rehabilitation as well as the improvement of the patient's health status.

Key words: alteration; dog; joint; LCPD; therapy

INTRODUCTION

Legg-Calvé-Perthes disease (LCPD), also named Perthes disease or *coxa plana* or avascular and aseptic necrosis/osteonecrosis/bone infarction of the femoral head is a developmental multifactorial disease of the hip joint that occurs at a young age (5–8 months) in dogs of small breeds weighing up to 12 kg. The etiology of the disease

is still unclear, but there is a high probability of the presence of a genetic predisposition, while the pathological process of LCPD can also be influenced by age, breed, diet composition, metabolic disorders such as obesity, gender and the concentration of sex hormones in the blood. The most predisposed dogs are small and toy breed dogs such as Yorkshire Terrier, West Highland White Terrier, Manchester Terrier, Cairn Terrier, Pug, Australian Shepherd, Dachshunds, Poodle and Chihuahua [1].

Legg-Calvé-Perthes disease is a difficult disorder to diagnose the first disease stage. The reason is the fact when pathological changes develop inside the joint before the first clinical symptoms are observed. Pathological processes related to the joint cartilage, epiphyses and metaphyses of the femur have a multifactorial origin, but they most often arise as a result of decreased or stopped blood supply to the proximal epiphysis of the femur before the closure of the growth plate on the head in which the bone tissue necrosis takes place [16]. Bone trabeculae necrosis creates cracks in the proximal epiphysis of the femur, with the remaining trabeculae are unable to carry the mechanical stress and collapse forming the microfractures and the cartilage is eventually crushed [10].

As the disease progresses, typical symptoms develop, such as lameness of varying degrees (interval from 1 to 5) [14] to non-weight-bearing of the limbs, pain and, in the case of long-lasting LCPD, atrophy of the gluteal and quadriceps muscles of the affected pelvic limb. The diagnosis is usually established on the basis of anamnesis, characteristic clinical symptoms (pain, possibly also swelling), clinical and X-ray examination. CT and MRI examination will provide the most correct results.

The clinical lameness scoring system for assessing dogs include three criteria [14], lameness, pain on palpation and weight-bearing. According to the scale for orthopedic lameness of small animals, 5 levels are distinguished with the following characteristics: grade 1 – the dog walks normally; grade 2 – slightly lame when the dog is walking; grade 3 – moderately lame when the dog is walking; grade 4 – severely lame when the dog is walking; grade 5 – the dog is reluctant to rise and will not walk more than five paces.

The disease is radiographically classified according to five grades: in grade 1, the acetabulum and contour of the femoral head as well as the femoral neck are normal, but there is a wide joint space, decreased density of the

femoral head and the femoral neck; in grade 2, there is a femoral head flattening and the presence of multiple density foci of decreased density, the acetabular rim may contain a small spur; in grade 3, there is an irregularity in the articular surface of the femoral head and the presence of multiple low density foci, the spur is more prominent in the acetabular rim; in grade 4, there is loss of the normal shape of the femoral head, increased prevalence of areas with decreased density; in grade 5, there is fragmentation of the femoral head with discontinuity of the articular surface, and the acetabular changes are more pronounced than those observed in grade 4 [3].

In dogs, three distinct histologic grades are described, involving microscopical changes leading to the development of a pathological process. Grade 1, that of necrosis, is characterized by empty osteoplasts and absence of viable bone marrow, while the chondrocytes of the joint and growth cartilage remain normal. In grade 2, cracks appear in the joint cartilage while the subchondral bone collapses in depth, thus leading to a flattening of the femoral head. Re-vascularization starts at the periphery of the epiphysis and at the same time, granulation tissue develops in the altered area. In grade 3, the articular cartilage is highly deformed with folds and cracks, and the femoral head loses its sphericity. At this grade, LCPD is considered irreversible, because the collapse of the anatomical contours, associated with remodeling mechanisms, permanently alters the contours of the femoral head [6].

The dogs with LCP disease were presented with severe hindlimb lameness, reluctance to move, severe pain at the palpation of the hip and muscular hypotrophy or atrophy. The procedure of diagnostics also consists in a standard radiograph projection of both hips to assess the severity and grading (named as the Ljunggren's scale) of LCPD described by Ljunggren [9] and modified by Crovace [5]. LCPD grade/scale by radiographic description consists of five grades of pathological process in the femoral head as well as neck (Table 2) [2].

The aim of this study was to evaluate the results of monitored patients, dogs 4 to 10 months old, with suspicion of the onset and development of LCPD. In accordance with the Ljunggren's scale, inclusion criteria of dogs with LCPD were determined by clinical examination (pain on palpation, response to manipulation, affected side of the hip joint, lameness grade and length, crepitation, muscle atrophy) and by radiographic features of the disease.

MATERIALS AND METHODS

The objective of this study was to evaluate a population of dogs ($n = 43$) in age interval from 4 to 10 months for suspected occurrence of LCPD. The following dog breeds were included in the evaluated study: Cairn Terrier ($n = 3$), Manchester Terrier ($n = 1$), Australian Shepherd ($n = 2$), Pug ($n = 4$), West Highland White Terrier ($n = 6$), Dachshunds ($n = 4$), Chihuahua ($n = 3$), Miniature Pinscher ($n = 1$), Miniature Poodle ($n = 1$), Lhasa Apso ($n = 2$), Boston Terrier ($n = 3$), Welsh Terrier ($n = 2$) and Yorkshire terrier ($n = 11$).

The documentation and information about the health status of the patients were provided by a veterinary clinic in Hungary under the guidance of Dr. Otto Sebő.

Ethical consideration

Within the framework of ethical considerations regarding this study, factors causing anxiety and fear in patients were controlled and eliminated by a veterinarian in the presence of the owner of the examined animal. Anonymity was also maintained within the framework of protection and data collection. The owners of the animals agreed in advance to the examination of the patients as well as to the inclusion of information about their health condition in the study.

The signalment factors of dogs (breed, gender, age), the affected hind limb, time of occurrence, clinical signs at the moment of patient consultation (pain on palpation, response to manipulation, lameness grade and length, crepitation, muscle atrophy), radiographic appearance of the lesion (the presence of avascular necrosis of the femoral head in order to characterize the disease), and the type of treatment were evaluated.

The population of dogs with a predisposition to Legg-Calvé-Perthes disease were examined in a veterinary clinic due to suspicion of orthopedic-locomotor apparatus disease, especially of the hind limbs, while the involvement of the joint/joints was determined, namely unilateral – left, right, or bilateral (both joints affected).

Clinical symptoms such as lameness (grade and length) were monitored by adspersion while the patient entered and moved in the veterinary clinic. Based on the standard values described by Nganvongpanit et al. [14], the patients were classified into one of the 5-grades – from no lameness to chronic lameness up to disability to put weight on the limb (Table 1).

Table 1. Lameness grades

Lameness grade	
1	No lameness
2	Mild lameness
3	Intermittent lameness
4	Frequent or severe lameness
5	Chronic lameness up to disability put weight on the limb

Source: Nganvongpanit et al. [14]

In addition, additional anamnestic data such as lameness duration are important. This information was provided by the dog owners based on the observation of the movement of dogs in their home environment. The lameness length was divided into 3 intervals, namely initial lameness up to two weeks, lameness from two weeks to one month, and finally lameness lasting more than one month.

The clinical lameness scoring system involves additional criteria obtained during patient examination in veterinary clinic such as response to patient manipulation, pain palpation with crepitation in the affected area and

Table 2. Characteristic of the Ljunggren's score in LCPD

Ljunggren's score/scale	Description of LCPD development based on X-ray examination
I	The femoral head and neck have a normal shape; joint space is enlarged, the acetabulum is physiologically shaped with little radiolucent areas
II	The head of the femur is flattened, the neck is affected by osteophytes, larger radiolucent areas are present
III	Greater degree of flattening of the femoral head, joint irregularity areas, irregular radiodensity and osteophyte formation
IV	Loss of the physiological shape of the femoral head, size radiolucent areas alternate with small areas, physiological bone density
V	Extensive fragmentation and deformation of the femoral head, signs of joint surface discontinuities

Source: Ljunggren [9]; Crovace et al. [6]

muscle atrophy of affected hind limb detected by adspec-tion and palpation.

As part of the X-ray examination, the condition of the affected hip joint was determined based on the Ljunggren's scale [9], which defines 5 degrees of affected structures involvement of the hip joint (Table 2).

Based on the formulating a diagnosis, the data on pharmacological and non-pharmacological therapy of patients with LCPD were processed. The therapy included conservative therapy (especially antipyretic, analgesic and nonsteroidal antiinflammatory drugs) and/or surgical therapy (head and femoral neck excision) with post-operative health management of dog patients.

RESULTS

The youngest LCPD patients included in this study were only 4 months old (female gender) at the first time of veterinary clinic visit. Another age category of dogs (n = 7) was 5 months old with 3 males and 4 females. There was a bigger gender difference in puppies at the age of half a year, namely 6 males and 3 females. Affected male dogs in this age category (6 months aged), represented 26.08 % of all males (n = 23) and 13.95 % of the total number of patients (n = 43).

In the group of dogs aged 7 months there were 6 most affected bitches and 4 males. This age group included the most affected LCPD (23.25 % of the total number of dogs). The group of 8 months old dogs included 5 males and 4 females while 4 males and 1 female were affected in 9-month-old dogs group. The oldest LCPD dog patient was 10 months old and suffered from chronic lameness and muscle weakness atrophy of the left pelvic limb (Table 3).

Table 3. Age and gender of the observed LCPD patients (n = 43)

Age (months)	Gender	
	Male	Female
4	0	2
5	3	4
6	6	3
7	4	6
8	5	4
9	4	1
10	1	0
Total (n)	23	20

The most characteristic clinical symptom of Legg-Calvé-Perthes disease in selected patients was lameness. This symptom occurred in all observed dogs, while lameness grade was determined in grades interval from 1 to 5 (Table 4).

Table 4. Lameness rate in the observed LCPD patients (n = 43)

Lameness	Lameness grade	LCPD patient number
No lameness	1	0
Mild lameness	2	2
Intermittent lameness	3	8
Frequent or severe lameness	4	26
Chronic lameness up to disability of hindlimb weight-bearing	5	7

Two patients showed a mild degree of lameness with normal sitting posture and standing, but rarely limped slightly when walking, but lameness after another 2–3 steps was not present due to the fact that the pathological condition in the hip joint was not advanced. The conservative therapy was given as part of the treatment.

The other lameness degree 3 indicates dogs with intermittent limping that sometimes goes away and then comes back and it restricts further movement of the patient. This type of lameness was 4 times more frequent in patients (n = 8) compared to the previous lameness grade 2 (n = 2). For most of these cases surgery treatment was recommended and subsequently performed.

The largest number of the monitored dogs had severe lameness in all types of walking, specifically 60.46 % of patients (n = 26) were affected by severe, longer lameness (lameness grade 4). In addition to the affected limb, other clinical symptoms, such as pain and crepitation of the articular joint during walking were observed.

The last group classified as lameness grade 5 included dogs (n = 7) with irreversible chronic pathological processes in the area of the head and neck of the femur as well as with severe pain during all types of movement, accompanied by crepitation of the joint and vocalization of the animal. Skeletal muscles atrophy of the affected hindlimb was observed in dogs and these patients were unable to stand and tried to use only forelimbs for weight-bearing while moving.

When analyzing the duration of lameness, it was found that only 7 dogs (16.28 %) showed initial stage of lameness lasting less than 2 weeks. In another group of patients

(n = 15; 34.88 %), longer lasting lameness was observed in which the patients' abnormal movement did not disappear after two weeks, but lasted less than a month. Almost half of all patients (n = 21; 48.84 %) suffered from long-lasting various lameness degree (more than one month), while the lameness appeared as recurring after a certain time, for example in 1–2 days.

The prevalence of the unilateral form of LCPD in the pelvic limbs observed in 46.51 % of dogs (n = 20) with pathologically changed left hip joint resembled that with the involvement of the right hip joint observed in 18 patients (41.86 %). In the other patients (n = 5) there was determined bilateral involvement of the both hip joints with advanced disability in one joint and the lower degree of damage in second hip joint. This group of dogs showed longer-lasting or intermittently appearing symptoms, mainly lameness of 2nd, 3th and 4th grade with difficult movement.

Clinical symptoms such as pain on palpation (yes/no), response to manipulation (yes/no), weight-bearing (yes/no), muscle atrophy of *mm. gluteales* and *m. quadriceps femoris* (yes/no) and crepitation (yes/no) are described in Table 5.

Table 5. Selected clinical symptoms in LCPD dogs (n = 43) expressed in %

Clinical symptoms	Number/% of LCPD dogs with symptom	
	Yes	No
Response to manipulation (yes/no)	42/97.6 %	1/2.4 %
Pain on palpation (yes/no)	33/76.7 %	10/23.3 %
Weight-bearing (yes/no)	2/4.7 %	41/95.3 %
Muscle atrophy (yes/no)	17/39.5 %	26/60.5 %
Crepitation (yes/no)	24/55.8 %	19/44.2 %

To establish the correct diagnosis is very important to determine the therapy for LCPD, whereby different diagnostic methods can be used. The first step is always communication with the owner with the aim of obtaining anamnestic data. The next step is clinical examination of

the patient, which consists of an adsppection as well as a palpation of body and orthopaedic examination. However, to confirm the patient's diagnosis, it is necessary to use imaging methods such as X-ray, CT or MRI.

The patients evaluated in our study were examined radiographically (X-ray method, Fig. 1) in the ventrodorsal position with suspicion of the occurrence of pathological changes in the basic anatomical structures, size, shape and location of hip joint to the acetabulum. The degree of damage to the hip joint was evaluated based on the Ljunggren's score (Table 6).



Fig. 1. The LCPD dog-patient, right hindlimb with Ljunggren's score 5

Table 6. LCPD dogs (n = 43) under Ljunggren's score

Ljunggren's score	Number/% of LCPD dogs
I	0/0%
II	2/4.6 %
III	12/27.9 %
IV	22/51.1 %
V	7/16.2 %

Table 7. The most common drugs used during conservative pharmacotherapy of LCPD dogs

The most used drugs	Active ingredient	Group	Administration method
Carprox 100 mg tbl.	carprofen	NSAID	per os
Onsior 20 mg tbl.	robenacoxib	NSAID	per os
Tramvetol 50 mg tbl.	tramadol	NSAID	per os
Vetalgin inj. a.u.v.	metamizol-natrium monohydrate	analgesic/antipyretic	i. v., i. m.

Early stages of the LCPD disease (with Ljunggren's score I – II) do not require surgical treatment, it is possible to start the treatment with conservative pharmacotherapy, but less often leading to a complete recovery of patient. The drugs most often used for conservative pharmacotherapy of LCPD dogs are described in Table 7.

In the investigated patients with Ljunggren's score III (n = 41) the invasive surgical method was used: femoral head and neck excision; an arthrotomy with a craniolateral approach to the joint; separation of the joint; connection and subsequent resection of the head and neck of the femur. This *procedure is used to treat painful hip conditions*, eliminate pain, discomfort and abnormal movement of LCPD dogs.

After surgery, persistent post-operative rehabilitation is very important to achieve correct results. The first post-operative control examination was done 10–12 days after surgery, due to removal sutures from the surgical wound. The next therapeutic step was to limit active movement during 2–3 months, then rest with short walking on a leash. After the control, X-ray examination was necessary to increase the interval of movement and gradual weight-bearing on the operated limb. Post-operative rehabilitation physiotherapy was also recommended.

DISCUSSION

Legg-Calvé-Perthes disease is a hereditary degenerative disease of the femoral head occurring in young puppies (5–8 months) of small dog breeds (terriers, dachshunds, pugs, Chihuahuas, etc.) [11]. In our study, 81.39 % of patients belonged to the age range mentioned in the cited literature. The remaining observed patients (18.60 %) were 4, 9 and 10 months old.

E y a r e f e et al. [7] reported that the prevalence of LCPD disease in dogs is generally almost the same in both sexes, which was also confirmed in our study. We found LCPD prevalence in 53.48 % of male and 46.51 % of female dogs.

A typical clinical symptom of LCPD is lameness, which is a sign of an advanced state of the disease, when internal pathological processes affect the joint depending on the degree of lameness [4]. There was observed lameness, mild, intermittent or frequent, in all evaluated patients, which meant that the hip joint was already pathologically changed and this health issue necessitated treatment.

When establishing the diagnosis of LCPD, a comparison of both pelvic limbs is recommended and the potential atrophic muscle changes, abnormal posture or minimal shortening of the affected pelvic limb with LCPD are determined. It was reported that in 85–90 % of disease cases unilateral involvement of the hip joint is observed with the pathological process affecting only the right or the left hip joint. In small percentages, LCPD can influence both hip joints (bilateral disability), which means an enormous problem with the movement as well as the state of health of the animal during the development of the disease as well as during rehabilitation [13]. This fact was confirmed by the results of our study, when in 11.63 % patients (n = 5) bilateral involvement of the both hip joints was diagnosed with longer-lasting or intermittently appearing symptoms, mainly lameness of 2nd, 3rd and 4th grade.

In the initial stage, LCPD is almost undetectable and visible radiological changes appear only within the progression of the disease. The main observed signs are: a decrease in density bone tissue of the head and neck of the femur; widening of the joint gap between the femur and acetabulum; creation of new bone structures – osteophytes on the edge of the acetabulum and possibly subchondral fractures of the femur [15].

With the consent of dog's owners, some patients with aseptic osteonecrosis of the femur in the early stage were put on conservative therapy which consisted of restricting the patient's movement and regular administration of anti-inflammatory and analgesic drugs. The most important therapeutic aspect is to limit the patient's movement so that the head of the femur is sufficiently fixed inside the acetabulum during the joint development. This rest can last 2–3 months, which is sometimes difficult to follow in active puppies [1]. The use of chondroprotective ingredients to support activity of osteoblasts was also recommended.

T r o s t e l et al. [17] reported the use of the Ehmer sling in patients in order to maintain the hip joint in a physiological position, but in our case this is not commonly used method.

As medical therapy, anti-inflammatory and analgesic drugs are most commonly administered for the purpose of eliminating pain and supporting the animal's normal movement [12]. Drugs from this group were most often used as oral preparations due to easy administration. In our clinic, in the majority cases the veterinarian recommended Carprox (with the active ingredient carprofen), an anti-in-

flammatory drug in the tablet form in different packaging (20 mg, 50 mg, 100 mg) depending on the weight of dog. The permitted dose is 4 mg.kg⁻¹ body weight, divided into 2 doses daily for 7 days. If a medical condition requires continued use of this medication, reduction of the dose is required to 2 mg.kg⁻¹ body weight per day.

Of the other oral pill forms of the anti-inflammatory drugs there was used Onsior with the active ingredient robenacoxib. To some patients with a severe pain condition Tramvetol with an analgesic effect from the opioid group was administered. It contains an active ingredient tramadol that affects the central nervous system by inhibiting feedback absorption of norepinephrine and serotonin in the brain producing a euphoric effect which results in dulling of pain.

In most cases, surgical intervention of the affected hip joint was necessary in patients, namely excision of the head and neck of the femur in dogs with Perthes disease. This method is based on the surgical resection of these two anatomical structures in order to eliminate pain and improve the patient's health [8].

After the reelevant procedure was performed and the post-operative period elapsed, the patients were monitored by X-ray with the aim to determine the healing status of the femur and correct use of the limb.

CONCLUSIONS

Legg-Calve-Perthes disease is an easily overlooked disorder of the hip joint in small dog breeds, given that many factors can contribute to the development of pathological processes in the affected joint. It is necessary to realize that there are many etiological factors influencing the development of LCPD (age, breed, diet, physical activity, etc.). Due to the predisposition to this disease in some small breeds of dogs, regular monitoring of the patients' health is very important. The first visible symptom is lameness of varying degrees, which indicates a possible orthopedic disease of dog. Prophylaxis consists in early diagnosis of LCPD using X-ray images that show developmental anomalies of varying degrees on the head and the neck of the femur of the pelvic limb. Following the diagnosis, it is necessary to decide on the most suitable therapeutic method based on the stage of the disease, which can be conservative, medical or surgical with subsequent long-term postoperative rehabilitation.

In order to achieve the best results, an excisional osteotomy of the head and neck of the femur is recommended as a part of the surgical procedure, which supports the improvement of the patient's clinical condition with the elimination of painful symptoms.

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Conflict of interest

The authors declare no conflicts of interest related to this report.

REFERENCES

1. Aguado, E., Goyenvalle, E., 2021: Legg Calvé Perthes disease in the dog. *Morphology*, 105, 349, 143–47. DOI: 10.1016/j.morpho.2020.11.011.
2. Bufalari, A., Crovace, A., Di Meo, A., Petrescu, V. F., Petreaca, A., Pascucci, L., et al., 2019: Preliminary clinical evaluation of mesenchymal stromal cell treatments for ununited anconeal process and Legg-Calvé-Perthes disease in dogs, scientific works. *C. Vet. Med.*, LXV, 1, 2067–3663.
3. Cardoso, C. B., Rahal, S. C., Mamprim, M. J., Oliveria, H. S., Melchert, A., Coris, J. G., Dos Reis Mesquita, L., 2018: Avascular necrosis of the femoral head in dogs – retrospective study. *Acta Sci. Vet.*, 46, 1, 5. DOI: 10.22456/1679-9216.86669.
4. Cardoso, C. B., Rahal, S. C., Mamprim, M. J., Oliveira, H. S., Melchert, A., Coris, J. G. F., Mesquita, L., 2018: Avascular necrosis of the femoral head in dogs – retrospective study. *Acta Sci. Vet.*, 46, 1537. DOI: 10.22456/1679-9216.81845.
5. Crovace, A., 2013: Implantation of autologous bone marrow mononuclear cells as a minimal invasive therapy of Legg-Calvé-Perthes disease in the dog. In: 2nd International Conference and Exhibition on Orthopedics and Rheumatology, Accepted abstracts. *J. Orthop. Musc. Syst.*, 2, 2. DOI: 10.4172/2161-0533.S1.014.

6. **Crovace, A. M., Lacitignola, L., Staffieri, F., Francioso, E., Rossi, G., Crovace, A., 2020:** Treatment of monolateral Legg-Calvé-Perthes disease with autologous bone marrow mononuclear cells in 32 dogs. *Clinic. Comm.*, 3, 1, e1–e10. DOI: 10.1055/s-0040-1701470.
7. **Eyarefe, O. D., Oyetayo, S. N., Adetunji, A., 2019:** Prevalence and pattern of nontrauma induced bone disorders among young dogs presented at the veterinary teaching hospital, University of Ibadan, Nigeria. *Nigerian Vet. J.*, 40, 4. DOI: 10.4314/nvj.v40i4.5.
8. **Johnson, K. A., 2010:** Outcome of femoral head ostectomy in dogs and cats. *Vet. Compar. Orthop. Traumatol.*, 23, 5, 3–4. DOI: 10.3415/VCOT-10-08-0125.
9. **Ljunggren, G., 1967:** Legg-Perthes disease in the dog. *Acta Orthop. Scand.*, 95, 1–79.
10. **Mazloumi, S. M., Ebrahimzadeh, M. H., Kachooei, A. R., 2014:** Evolution in diagnosis and treatment of Legg-Calvé-Perthes disease. *Arch. Bone J. Surg.*, 2, 2, 8692. DOI: 10.22456/1679-9216.81845.
11. **Meeson, R. L., Todhunter, R. J., Blunn, G., Nuki, G., Pittsillides, A. A., 2019:** Spontaneous dog osteoarthritis – a One Medicine vision. *Nat. Rev. Rheumatol.*, 15, 5. DOI: 10.1038/s41584-019-0202-1.
12. **Millis, D. L., 2017:** Legg-Calvé-Perthes disease in dogs. *Vet. Foc.*, 3, 27, 9–17. DOI: 10.1016/j.morpho.2020.11.011.
13. **Mills, S., Burroughs, K. E., 2024:** *Legg-Calve-Perthes Disease*. Updated 2023, July 10. In StatPearls Internet. Treasure Island, FL, StatPearls Publishing. Available at <https://www.ncbi.nlm.nih.gov/books/NBK513230/>.
14. **Nganvongpanit, K., Boonsri, B., Sripratak, T., Markmee, P., 2013:** Effects of one-time and two-time intra-articular injection of hyaluronic acid sodium salt after joint surgery in dogs. *J. Vet. Sci.*, 14, 2, 215–222. DOI: 10.4142/jvs.2013.14.2.215.
15. **Purdoiu, R. C., Lacatus, R., Popovici, C., Papuc, I., 2016:** Ultrasound findings in hip joint in dogs with avascular necrosis of the femoral head. *Luc. Ştiin. Med. Vet.*, 4, 3–5.
16. **Thak, M., Yoon, H. Y., Jeong, S., 2013:** Early stage Legg-Calve-Perthes disease in a dog: Clinical, surgical, radiological, computed tomography and histological findings. *J. Vet. Clin.*, 30, 5, 366–370.
17. **Trostel, C. T., Pool, R. R., McLaughlin, R. M., 2005:** Canine lameness caused by developmental orthopedic disease: panosteitis, Legg-Calvé-Perthes disease, and hypertrophic osteodystrophy. *Com. Cont. Educ. Pract. Vet.*, 25, 4, 282–293.

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