



A LITERATURE REVIEW: HIP DYSPLASIA IN DOGS

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Abstract

Hip dysplasia is a common orthopedic disorder affecting dogs. It can be caused by various factors, such as genetics, growth rate, lifestyle, and trauma. This literature review aims to compare clinical signs and symptoms, maintenance examinations, radiological images, treatment, and therapy from various national and international literature on hip dysplasia in dogs. Literature was identified through Pubmed and Google scholar using the keywords “hip dysplasia in dogs case report” and “hip luxation in dogs case report,” with articles published between 2020 and 2023 selected as supporting references. The four cases involved dogs of different breeds, ages, and body weights and presented with varying clinical manifestations, including hind-limb lameness, difficulty bearing weight, reluctance to move, abnormal gait, difficulty climbing stairs, and muscle atrophy. Radiographic examination revealed abnormalities including hip joint incongruity, shallow acetabula, femoral head flattening, chronic craniodorsal hip luxation, osteoarthritis, and osteophyte formation. The therapeutic approaches varied according to the clinical condition and severity of the cases, including underwater treadmill (UWT) therapy, total hip replacement (THR), femoral head and neck ostectomy (FHO), and conservative management involving weight control, analgesic therapy, and chondroprotective supplementation. Overall, the findings indicate that clinical and radiographic evaluation is essential for determining the severity of hip disorders and selecting appropriate treatment. Individualized management based on disease severity and clinical condition is important to reduce clinical signs, maintain mobility, and improve the quality of life of affected dogs

Keywords: *Hip Dysplasia (HD)*, X-ray, Caput femur, Acetabulum

INTRODUCTION

Hip dysplasia is a developmental orthopedic disorder in dogs characterized by abnormal development and instability of the coxofemoral joint, which may progressively lead to degenerative joint changes and impaired musculoskeletal function. The condition is associated with varying degrees of joint laxity, subluxation, and subsequent osteoarthritis, resulting in pain and reduced mobility (Syrcele, 2017). Although hip dysplasia can occur in dogs of various breeds, large and giant breeds are generally considered to be at greater risk, while certain brachycephalic breeds may also exhibit a high prevalence of the condition.

Clinically, affected dogs may exhibit difficulty in movement, stiffness of the hip joint, lameness, pelvic limb muscle atrophy, and a characteristic “bunny-hopping” gait, particularly during running or climbing stairs (Jasmin et al., 2023). The clinical manifestations are closely associated with the progressive deterioration of joint stability and the development of secondary osteoarthritis. Under normal conditions, the stability and function of the coxofemoral joint are maintained by the congruency of the articular surfaces, joint capsule, ligaments, and surrounding musculature. In dogs with hip dysplasia, excessive joint laxity alters the distribution of mechanical forces within the joint, resulting in cartilage damage, synovial inflammation, subchondral bone remodeling, and periarticular tissue changes. These pathological processes contribute to progressive pain, stiffness, and functional impairment.

The diagnosis of canine hip dysplasia is established based on the clinical history, orthopedic examination, assessment of joint range of motion, and radiographic evaluation. Radiography is an important diagnostic modality for assessing hip joint conformation, subluxation, and secondary degenerative changes. Although the anatomical abnormalities associated with hip dysplasia cannot generally be completely reversed, appropriate management can reduce clinical signs, minimize disease progression, and improve the quality of life of affected dogs (Pinna and Romagnoli, 2017). Therapeutic approaches include conservative management and surgical intervention, depending on the age of the dog, severity of clinical signs, degree of joint degeneration, and overall functional status. Conservative treatment may include controlled exercise, weight management, analgesic and anti-inflammatory therapy, and physiotherapy, particularly in dogs with mild to moderate clinical signs. However, progressive joint degeneration may result in persistent pain and functional impairment despite conservative management (Chaudhary et al., 2020). Surgical procedures such as total hip replacement (THR) and femoral head and neck ostectomy (FHO) may therefore be considered in selected cases to alleviate pain and improve limb function (Hummel, 2017; Engstig et al., 2022).

Given the progressive nature of canine hip dysplasia and its substantial impact on mobility and quality of life, an understanding of its clinical manifestations, diagnostic findings, and available management strategies is essential. Therefore, this literature review aimed to summarize and compare findings from previous studies concerning the clinical signs, physical and ancillary examination findings, radiographic characteristics, diagnosis, management, and therapeutic approaches of hip dysplasia and related hip disorders in dogs. This review is expected to provide a concise overview of findings reported in previous studies and to serve as a reference for veterinarians and other animal health professionals in understanding the clinical characteristics, diagnostic considerations, and management options for hip dysplasia in dogs.

MATERIALS AND METHODS

Literature Search Strategy

The material utilized consists of data regarding signalment, physical examinations, ancillary tests, X-ray images, tentative diagnoses, management, and treatment protocols sourced from both national and international literature. The writing methodology involved examining a primary case and comparing it with findings from a literature review. This review gathered supporting data from various journals, conducted via Google searches using keywords such as “hip dysplasia in dogs case report” or “hip luxation in dogs case report.” The collected literature comprises a range of national and international journals published between 2020 and 2023.

Inclusion and Exclusion Criteria

The inclusion criteria were (1) studies or case reports published between 2020 and 2023, (2) publications discussing hip dysplasia or related hip disorders, (3) studies involving dogs as the

study subject, and (4) publications providing information regarding clinical findings, diagnostic examinations, radiographic findings, management, or treatment. Publications involving animal species other than dogs, studies unrelated to hip dysplasia or related hip disorders, and publications that did not provide relevant clinical, diagnostic, or therapeutic information were excluded.

Data Extraction and Analysis

Data were extracted descriptively from the selected publications and included signalment, clinical history, physical examination findings, ancillary examination results, radiographic findings, diagnosis, prognosis, management, and therapy. Four canine cases from the selected literature were reviewed and analyzed collectively to identify similarities and differences in clinical presentation, diagnostic findings, and therapeutic approaches. The extracted data were presented descriptively and compared across the cases to provide an overview of the clinical and radiographic characteristics and management strategies of hip dysplasia and related hip disorders in dogs.

RESULTS AND DISCUSSION

Results

Signalment and History

1. Primary Case

A five-year-old female Beagle dog with a white and light-brown coat and a body weight of 15.80 kg was presented to a veterinarian. According to the owner's history, the dog was reluctant to move and exhibited lameness in both hind limbs. The dog was brought to the veterinarian on day 3 after the onset of clinical signs. Appetite, defecation, and urination were normal. The dog had received complete vaccinations, and no skin disease or parasitic infestation was reported.

2. Comparison Case 1

A six-year-old spayed female Border Collie weighing 15 kg was presented with an inability to walk for more than two months. One of the hind limbs had been amputated more than one year previously.

3. Comparison Case 2

A nine-month-old male Labrador was presented to a veterinary clinic with a history of difficulty bearing weight and right hind-limb lameness during movement. The dog had received analgesic medication for several weeks but showed no response. In addition, the dog frequently exhibited signs of gastritis.

4. Comparison Case 3

A two-year-old male Rottweiler weighing 33 kg was presented to Eden Pets Care, a veterinary clinic in Mogappair, Chennai, with a history of abnormal gait, intermittent hind-limb lameness, reluctance to climb stairs, difficulty rising after rest, and exercise intolerance observed for two weeks.

Physical Examination

1. Primary Case

Physical examination was performed to ensure that the dog was in an appropriate condition before UWT therapy. The Body Condition Score (BCS) was 7/9. Respiratory

rate, heart rate, body temperature, skin turgor, skin condition, and mucous membranes were within normal limits. Additional examinations included pain scoring, lameness scoring, and assessment and measurement of the quadriceps muscles. Muscle mass was measured at a point corresponding to 70% of the line between the greater trochanter and the distal femur, at the lateral fibular point, using a Gulick II Tape.

2. Comparison Case 1

Orthopedic examination revealed moderate discomfort during examination of the left hip joint.

3. Comparison Case 2

Heart rate, respiratory rate, and body temperature were within normal ranges. Right hind-limb lameness was observed during movement, accompanied by signs of gastritis.

4. Comparison Case 3

The animal appeared lethargic during examination and showed intermittent lameness. The hind-limb muscles exhibited muscle atrophy, and the hind limbs were abnormally positioned close together, resulting in a narrow-based stance.

Ancillary Examination

1. Primary Case

Radiographs were obtained using a digital X-ray unit to establish the diagnosis and determine the appropriate treatment. Radiographs were taken in the ventrodorsal projection. The ventrodorsal projection is considered an appropriate technique for evaluating the canine hip joint according to the Fédération Cynologique Internationale and the British Veterinary Association (Flückiger, 2007; Hammond & McConnell, 2016). Radiographic evaluation revealed incongruity between the femoral heads and acetabula, as well as morphological changes in the craniolateral acetabular rim.

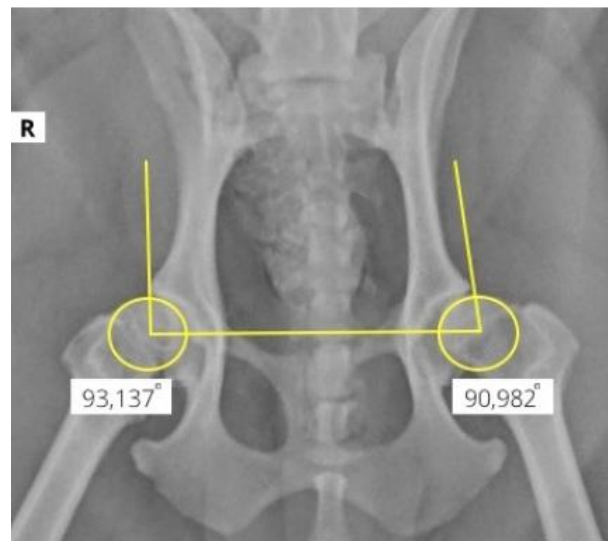


Figure 1. Norberg angle of the canine hip joints before underwater treadmill therapy.

2. Comparison Case 1

Radiographic examination revealed chronic craniodorsal hip luxation.

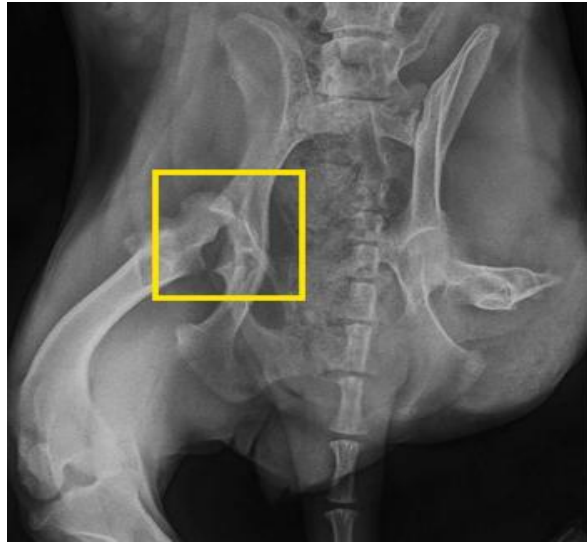


Figure 2. Preoperative radiograph showing craniodorsal hip luxation and contralateral pelvic limb amputation.

3. Comparison Case 2

Ventrodorsal radiographs of both hip joints showed shallow acetabular cavities accompanied by flattening of the right femoral head (Figure 3).



Figure 3. Radiograph showing a shallow acetabular cavity and flattening of the right femoral head.

4. Comparison Case 3

Radiographic examination in the ventrodorsal view showed shallow acetabula and osteoarthritic changes with osteophyte formation (Figure 4).

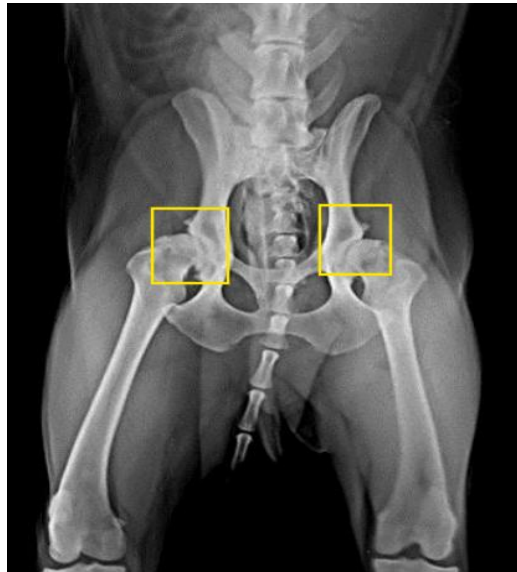


Figure 4. Radiograph showing hip dysplasia.

Diagnosis and Prognosis

1. Primary Case

The diagnosis of HD in the dog was established based on the medical history, clinical signs, physical examination, and radiographic findings. According to the FCI hip dysplasia grading system, the dog had bilateral moderate HD and morphological changes involving the craniolateral acetabular rim. As shown in Figure 2a, the Norberg angle (NA) of the left hip joint was 90.982° , whereas the NA of the right hip joint was 93.137° . Hip joint morphometry showed NA values between 90° and 100° for both hip joints, corresponding to moderate HD. Palpation of the hind-limb muscles revealed weakness in both hind limbs. Palpation and muscle measurements indicated muscle atrophy. Therefore, the dog was diagnosed with moderate bilateral hip dysplasia with a favorable prognosis.

2. Comparison Case 1

Based on the physical and ancillary examinations, including X-ray examination, the case was diagnosed as chronic craniodorsal hip luxation with a favorable prognosis.

3. Comparison Case 2

Based on the physical and ancillary examinations, including X-ray examination, the case was diagnosed as hip dysplasia associated with osteoarthritis of the right hip joint, with a favorable prognosis.

4. Comparison Case 3

Based on the physical and ancillary examinations, including X-ray examination, the case was diagnosed as hip dysplasia associated with osteoarthritic changes and osteophyte formation.

Management

1. Primary Case

The dog received non-invasive therapy using an underwater treadmill (UWT). Muscle mass, ROM, pain score, lameness score, and radiographic images were evaluated before and after 10 UWT sessions. The evaluations were performed to assess changes before and after therapy. The duration of each UWT session was adjusted according to the animal's ability. UWT was performed once weekly for a total of 10 sessions, with a maximum speed of 3 km/h. The water temperature was maintained at 28–32°C (Levine et al., 2016; Chiquoine et al., 2018). The UWT pool measured 1.56 m in length, 0.53 m in width, and 0.73 m in height. The right and left sides of the pool were made of glass to allow the veterinarian to observe the animal during therapy, while the front, rear, and corners of the pool were made of stainless steel. The control panel allowed the device to be switched on and off and the UWT speed to be adjusted. Duration, speed, distance traveled, and calories burned were displayed on the UWT monitor. Water depth was adjusted according to the dog's height at three anatomical levels: the tarsal joint, knee, and hip.

2. Comparison Case 1

Conservative treatment consisting of reduction and Ehmer sling application had previously been attempted by several veterinarians but was unsuccessful. Therefore, total hip replacement (THR) using the InnoPlant system was performed after discussion with the owner. Premedication consisted of medetomidine (0.02 mg/kg IM), methadone/Synthadon (0.5 mg/kg IM), meloxicam (0.2 mg/kg SC), and cefazolin (22 mg/kg IV), followed by induction of anesthesia with propofol (3 mg/kg IV) and maintenance with isoflurane.

The surgery was performed in lateral recumbency using a craniodorsal approach. A deep gluteal incision revealed severe cartilage loss at the femoral head, whereas the acetabulum showed no substantial changes apart from soft-tissue swelling. A cementless femoral stem was selected based on fit following sequential reaming. The acetabulum was prepared and a screw cup was placed at a 45° angle, followed by placement of the femoral stem in a neutral anteversion position. After selecting the appropriate femoral head size, the joint was reduced and stability and impingement were evaluated. The wound was closed using a continuous suture pattern, and the patient was placed in a cage with soft bedding for recovery.

3. Comparison Case 2

The area over the right hip joint was prepared for aseptic surgery. Anesthesia was induced with propofol at 6 mg/kg body weight intravenously, and the dog was maintained under inhalation anesthesia with isoflurane. The dog was positioned in lateral recumbency with the affected limb uppermost. A curved incision was made in the craniolateral skin over the hip joint. The biceps femoris muscle was retracted caudally and the tensor fasciae latae cranially. After incision of the vastus lateralis muscle, the muscle was reflected ventrally. Finally, the joint capsule was incised and the right femoral head was excised using a wire saw (Figure 2). The muscles, tendons, and skin were subsequently closed with continuous sutures.

4. Comparison Case 3

This case was managed clinically using a conservative approach.

Therapy

1. Primary Case

During UWT therapy, the dog received Synoquin® EFA twice daily. The dog was fed 210 g/day of Royal Canin® Satiety to maintain body weight. No NSAIDs or other medications were administered.

2. Comparison Case 1

Postoperatively, Synthadon (0.5 mg/kg IM) was administered every 8 hours for 24 hours, together with meloxicam, gabapentin, paracetamol, and cephalexin as multimodal therapy. The patient was discharged the following day with instructions for strict cage rest for 6–8 weeks. Follow-up therapy consisted of cephalexin, gabapentin, and paracetamol for 5 days (twice daily), and meloxicam for 5 days (once daily). Standing was not recommended during the first 4 weeks, after which activity was gradually increased with assistance.

Orthopedic evaluation 4 weeks postoperatively showed that pain on hip manipulation had almost completely resolved. The patient was able to stand without assistance by week 10 and gradually walked independently over the following 6 weeks. No complications were identified during the mid-term clinical and radiographic evaluation.

Radiographs obtained 12 weeks postoperatively showed no implant loosening, displacement, radiolucency at the bone–implant interface, or femoral stem subsidence. Although long-term radiographic evaluation was not available, the clinical outcome was considered very good by the owner up to 12 months, with substantial improvement in mobility and quality of life.

3. Comparison Case 2

Postoperatively, the dog received broad-spectrum antibiotics, analgesics, and a neurotonic agent for 7 days, together with antiseptic dressings until the wound had completely healed. The owner was advised to massage the affected area and perform passive physiotherapy after healing to prevent muscle atrophy. Two months after surgery, the animal began walking while bearing full weight, with only mild lameness.

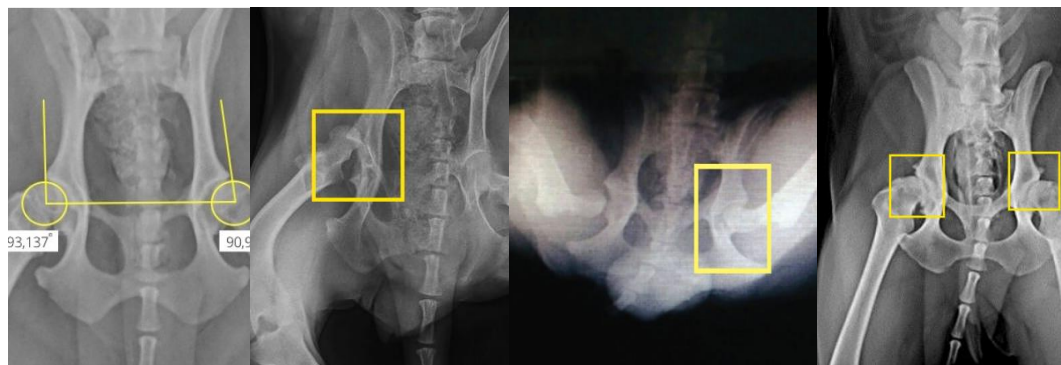
4. Comparison Case 3

The dog was treated with Cosequin tablets (chondroitin sulfate, hyaluronic acid, and glucosamine) for two months and carprofen tablets at a dose of 4.4 mg/kg for 14 days. Cosequin was administered at three tablets daily for four weeks, followed by two tablets daily for the subsequent four weeks. The dog was fed a veterinary prescription diet for obesity, and the owner was advised to avoid giving other fast-food products to the pet. Clinical improvement was observed, with resolution of lameness and increased activity. The importance of continuing the chondroprotective agent at a maintenance dose and maintaining optimal body weight was emphasized to the owner.

Table 1. Summary of Hip Dysplasia Cases in Dogs

Case	Primary Case	Comparison Case 1	Comparison Case 2	Comparison Case 3
Authors	Jasmin et al. (2023)	McCartney dan Ober (2023)	Chaudhary et al. (2020)	Balima dan Rajasekaran (2020)
Literature Title	Terapi Underwater Treadmill untuk Penanganan Hip Dysplasia pada Anjing Beagle	Case report: Total hip replacement using Innoplant system in a dog with chronic hip luxation and contralateral pelvic limb amputation	Femoral Head Ostectomy in A Dog Suffering from Hip Dysplasia	Conservative management of hip dysplasia in a dog
Signalment	Five-year-old female Beagle, white and light-brown coat, body weight 15.80 kg.	Six-year-old spayed female Border Collie, body weight 15 kg.	Nine-month-old male Labrador.	Two-year-old male Rottweiler, body weight 33 kg.
History	The dog was reluctant to move and lame in both hind limbs. It was presented to a veterinarian on day 3. Appetite, defecation, and urination were normal. The dog had received complete vaccinations, and no skin disease or parasites were reported.	The dog was presented with an inability to walk for more than 2 months. One hind limb had been amputated more than 1 year previously.	The dog had difficulty bearing weight and right hind-limb lameness during movement. Analgesics had been administered for several weeks without response. The dog also frequently showed signs of gastritis.	The dog had an abnormal gait, intermittent hind-limb lameness, reluctance to climb stairs, difficulty rising after rest, and exercise intolerance observed for 2 weeks.
Physical Examination	BCS 7/9; respiratory rate, heart rate, body temperature, skin turgor, skin condition, and mucous membranes were normal. Muscle mass was measured at 70% of the line between the greater trochanter and distal femur at the lateral fibular point.	Orthopedic examination showed moderate discomfort during examination of the left hip joint.	Heart rate, respiratory rate, and body temperature were within normal ranges. Right hind-limb lameness was observed during movement, accompanied by signs of gastritis.	The animal appeared lethargic and showed intermittent lameness. Hind-limb muscle atrophy was observed, and the hind limbs were abnormally close together, producing a narrow-based stance.

Ancillary
Examination



Diagnosis	Moderate dysplasia	hip	Chronic craniodorsal hip luxation	Hip dysplasia associated with osteoarthritis of the right hip joint	Hip dysplasia associated with osteoarthritic changes and osteophyte formation
Management	Non-invasive UWT therapy. Muscle mass, ROM, pain score, lameness score, and radiographs were evaluated before and after 10 UWT sessions. Therapy was performed once weekly for 10 sessions, at a maximum speed of 3 km/h and a water temperature of 28–32°C. The UWT pool measured 1.56 × 0.53 × 0.73 m. Duration, speed, distance, and calories burned were displayed on the device monitor.		Total hip replacement (THR) using the InnoPlant system. Premedication included medetomidine, methadone/Synthadon, meloxicam, and cefazolin, followed by propofol induction and isoflurane maintenance. Surgery was performed in lateral recumbency using a craniodorsal approach.	Femoral Head and Neck Osteotomy (FHO). Propofol was administered intravenously at 6 mg/kg, with isoflurane for maintenance. The affected limb was positioned uppermost, a craniolateral incision was made, the relevant muscles were retracted, and the right femoral head was excised using a wire saw.	Conservative clinical management.
Therapy	Synoquin® EFA twice daily and Royal Canin® Satiety at 210 g/day for body-weight management. No NSAIDs or other medications were administered.		Postoperative Synthadon, meloxicam, gabapentin, paracetamol, and cephalexin as multimodal therapy, followed by strict cage rest for 6–8 weeks and gradual assisted activity.	Postoperative broad-spectrum antibiotics, analgesics, and a neurotonic agent for 7 days, with antiseptic dressings until wound healing. Massage and passive physiotherapy were recommended to prevent muscle atrophy.	Cosequin for 2 months and carprofen at 4.4 mg/kg for 14 days, together with a veterinary prescription obesity diet and weight management. Clinical improvement included resolution of lameness and increased activity.

Discussion

Hip dysplasia (HD) in dogs is an orthopedic disorder characterized by incongruity between the femoral head and acetabulum, resulting in hip joint instability followed by degenerative

changes such as osteoarthritis. This condition causes discomfort during walking, which can be assessed through physical examination, with lameness commonly observed and the diagnosis confirmed through radiographic examination (X-ray).

The four publications discussed hip dysplasia in dogs of different ages, breeds, and body weights. The primary case involved moderate HD in a five-year-old Beagle weighing 15.80 kg. The treatment consisted of an underwater treadmill walking program. UWT is a non-invasive therapy intended to control pain and prevent progression of HD in dogs (Dycus et al., 2017). In the primary case literature, rehabilitation with UWT was reported to increase muscle mass and muscle strength in dogs with HD.

The primary case dog was diagnosed with moderate HD after hip joint ROM was measured using goniometry. Range of motion (ROM) is the maximum angle through which a joint can move. Dogs with HD generally exhibit reduced ROM and difficulty during hip extension (Jasmin et al., 2023). Hip dysplasia grading in dogs can be assessed according to the FCI system (Flückiger, 2007). Comparison case 1 involved chronic craniodorsal hip luxation, as clearly shown in Figure 2, in which the femoral head was displaced from the acetabular cavity. This may have resulted from continuous weight bearing on the left hind limb after the right hind limb had been amputated. In the radiographic image of comparison case 2, the right femoral head was in contact with the acetabulum. This condition may explain the right hind-limb lameness, difficulty walking due to inability to support the body, and lack of response after several weeks of analgesic administration. A similar condition was observed in comparison case 3, in which both femoral heads were in contact with the acetabula.

Different treatments were provided in comparison case 1 (surgical treatment using THR), comparison case 2 (surgical treatment using FHO), and comparison case 3 (conservative management). Among the four publications, the primary case and comparison case 3 were managed without surgery, whereas comparison cases 1 and 2 underwent surgical treatment. This difference may be related to the abnormal relationship between the femoral head and acetabulum, which may have caused severe pain in comparison cases 1 and 2. Successful non-surgical management, as demonstrated in the primary case and comparison case 3, requires consistent treatment and substantial owner involvement to prevent progression of HD.

The medications administered also differed between the primary case and comparison case 3, which were managed without surgery, and comparison cases 1 and 2, which underwent surgery. Treatment in the primary case and comparison case 3 focused primarily on joint maintenance and body-weight management. Cosequin supplementation in comparison case 3 may be useful in advanced HD because it contains avocado/soybean unsaponifiables (ASU), which are not present in Synoquin, whereas Synoquin primarily focuses on joint lubrication through hyaluronic acid. Postoperative treatment in comparison cases 1 and 2 focused on recovery and included antibiotics, analgesics, and anti-inflammatory drugs.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the observations from the primary case and comparisons with supporting literature, it can be concluded that diagnosis of hip dysplasia requires integration of the medical history, clinical signs, physical examination, and radiographic findings to determine disease severity based on the Norberg angle. Management of hip dysplasia depends substantially on disease severity and the patient's clinical condition. Moderate cases may be managed with underwater treadmill therapy, whereas chronic cases may require surgical interventions such as THR or FHO. Successful management therefore does not rely on a single method but may involve a

combination of physical therapy, chondroprotective supplementation (glucosamine/chondroitin), body-weight management through dietary control, and NSAID administration when indicated to maintain the animal's quality of life

Suggestions

Treatment and therapy for dogs with hip dysplasia should be tailored to disease severity, as assessed by X-ray findings, pain scores, and other ancillary examinations such as goniometry. Owner commitment is essential to maintain consistent physical activity in affected dogs through appropriate walking or other activities, which may help prevent worsening of the condition and support long-term joint function.

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REFERENCES

- Chaudhary, R, N., Niwas, R., Kumar, S. 2020. Femoral Head Ostectomy in a Dog Suffering from Hip Dysplasia. *Explore Anim Med Res*. 10 (1): 73-74.
- Dycus DL, Levine D, Marcellin-Little DJ. 2017. Physical rehabilitation for the management of canine hip dysplasia. *Vet Clin Anim*. 47(4):823–850
- Engstig, M., Vesterinen, S., Morelius, M., Junnila, J., Hyytiainen, HK. 2022. Effect of Femoral Head and Neck Ostectomy on Canines Functional Pelvic. *Position and Locomotion Animal*, 12, 1631.
- Flückiger M. 2007. Scoring radiographs for canine hip dysplasia-the big three organization in the world. *EJCAP*. 17(2):135–140.
- Hummel, D. 2017. Zurich Cementless Total Hip Replacement. *Veterinary Clinics of North America: Small Animal Practice*. 47(4): 917–934.
- Jasmin, S., Amelia, F., Ichsanniyati, Z., Soehartono, H, R., Noviana, D. 2023. Terapi *Underwater Treadmill* untuk Penanganan *Hip Dysplasia* Pada Anjing Beagle. *Acta Veterinaria Indonesiana*. 11 (2): 122-130.
- Pinna, S., Romagnoli, N. 2017. Radiographic Measurement of the Quadriceps Angle in Dogs. *PLoS One*. 12(10):1–10.
- Syrle, J. 2017. Hip dysplasia: Clinical signs and physical examination findings. *Vet Clin North Am Small Anim Pract*. 47(4):769–775.