The Application of Osteopathy in Reducing Compensatory Strain in Dogs with Hip Dysplasia

By Courtney O'Regan

London College of Animal Osteopathy

Canine Osteopathy

Date: 07/04/2026

Introduction

Background on Canine Hip Dysplasia

Canine Hip Dysplasia (CHD) is one of the most prevalent orthopedic conditions it is a genetic disease that affects the hip joint of canines. While large breeds such as German Shepards, Labrador Retrievers and Great Danes are at a higher risk of developing hip dysplasia, it is not limited to large breeds, smaller breeds known to suffer with CHD are Pugs, Cavalier King Charles Spaniel and the Shetland sheepdog. (globaladmin, 2021). It is characterized by a developmental malformation of the coxofemoral joint, this in turn leads to joint laxity, abnormal biomechanics and ultimately developing into degenerative joint disease.

Clinical signs can vary greatly from patient to patient. Patients may present with a subtle gait abnormality to obvious lameness, reduced mobility and chronic pain. The impact of CHD is not just localized to the hip joint it extends beyond the affected joint. As the disease begins to progress dogs often develop compensatory patterns in areas such as the lumbar spine, sacroiliac joint and contralateral limbs as they attempt to redistribute load and maintain function. Because of these adaptations issues can often arise such as discomfort, altered movement and a reduced quality of life.

Conventional Treatments vs Complementary Treatments

Conventional treatments for canine hip dysplasia include surgical procedures such as total hip replacement, femoral head ostectomy, or juvenile pubic symphysiodesis, as well as conservative management strategies involving weight control, physiotherapy, non-steroidal anti-inflammatory drugs (NSAIDs), and nutritional supplements. (AKC Staff,

2025) While these treatments may provide varying degrees of relief, many dogs continue to experience biomechanical strain in regions away from the hip joint, arising as a consequence of long-term compensation. This highlights the importance of addressing not only the primary pathology but also the wider musculoskeletal system.

Osteopathy, as a manual therapy, emphasises a holistic understanding of the body, recognising that dysfunction in one region often produces strain and imbalance in others (Marsden, 2018). Within animal osteopathy, practitioners use a variety of techniques including soft tissue mobilisation, myofascial release, gentle articulatory methods, and craniosacral approaches to reduce restrictions, restore balance, and support optimal function (Pusey, Starke, & Coates, 2012). The osteopathic perspective is particularly relevant to conditions such as hip dysplasia, where compensatory strain is both a clinical hallmark and a major contributor to the animal's overall discomfort.

Although animal osteopathy is a relatively new and developing field, there is increasing interest in its potential role as a complementary therapy alongside conventional veterinary care. Evidence from human osteopathy suggests that manual interventions can alleviate compensatory strain, improve mobility, and support musculoskeletal health in conditions involving chronic joint dysfunction (Haussler, 1999). Extrapolating from these findings, osteopathy may hold similar benefits in the management of canine hip dysplasia, not by curing the underlying joint deformity, but by reducing secondary strain patterns that exacerbate disability and pain.

The aim of this thesis is to explore the application of osteopathy in reducing compensatory strain in dogs with hip dysplasia. The central research question is: Can

osteopathic techniques reduce compensatory strain patterns in dogs with hip dysplasia, thereby improving mobility and quality of life? The working hypothesis proposes that osteopathic intervention can alleviate secondary dysfunction in the lumbar spine, pelvis, and contralateral limbs, resulting in enhanced comfort and improved functional outcomes.

This paper will first review the pathophysiology of hip dysplasia and its associated compensatory mechanisms, before examining the principles of osteopathy and their application in veterinary practice. Finally, it will evaluate how osteopathic treatment may contribute to reducing compensatory strain, drawing on existing research, case studies, and clinical reasoning to highlight the potential role of osteopathy in supporting dogs with this common condition.

Hip Dysplasia and Compensatory Mechanisms

Anatomy and Biomechanics of the Canine Hip Joint

The canine hip joint is a synovial ball-and-socket articulation formed between the head of the femur and the acetabulum of the pelvis. In healthy dogs, congruency between the femoral head and acetabulum ensures even load distribution during locomotion, with stabilisation provided by the joint capsule, the ligament of the femoral head, and periarticular muscles such as the gluteals (Smith, Mayhew, & Kapatkin, 2001). The coxofemoral joint is designed to accommodate high levels of stress during activities such as running and jumping, and when properly formed, the forces are transmitted smoothly from the femur into the pelvis (Comhaire & Schoeman, 2016).

In hip dysplasia, abnormal joint development results in laxity of the capsule and poor femoral head coverage by the acetabulum. This leads to subluxation, altered biomechanics, and uneven load-bearing surfaces (Lust & Todhunter, 1989). Over time, these forces accelerate cartilage wear, stimulate periarticular fibrosis, and contribute to osteoarthritic changes (Innes & Barr, 1998). Importantly, the disease begins as a developmental disorder of joint laxity, but its long-term clinical significance lies in the secondary osteoarthritis and compensatory changes that follow.

Altered Loading in Hip Dysplasia

Dogs with hip dysplasia frequently present with abnormal gait mechanics, such as shortened stride length, reduced hip extension, and increased reliance on forelimbs for propulsion (Santana et al., 2022). These alterations arise from pain avoidance behaviours and mechanical inefficiency within the hip joint. As dogs shift weight-bearing away from the dysplastic hip, they load other regions more heavily, particularly the contralateral hind limb and the thoracic limbs (Comhaire & Schoeman, 2016).

Recent studies have highlighted that even conservative management does not fully normalise these patterns. For example, gait analysis in dogs treated for hip dysplasia has shown persistent asymmetry in ground reaction forces, suggesting long-term biomechanical adaptations (Kwananocha et al., 2023). These changes are clinically significant, as they lead to secondary strain in tissues that are not inherently pathological.

Compensatory Mechanisms in the Musculoskeletal System

The presence of hip dysplasia rarely affects only the hip joint. Dogs develop widespread compensatory strain as they attempt to maintain mobility and stability.

Lumbar Spine – The lumbosacral region often becomes hypermobile due to altered pelvic positioning. To compensate for reduced hip extension, the lumbar spine increases motion during gait, which can lead to muscular hypertonicity and secondary back pain (Haussler, 1999).

Sacroiliac Joint – The sacroiliac joint absorbs abnormal shear forces when hip stability is compromised. Clinical palpation often reveals restricted or painful sacroiliac mobility in dogs with chronic hip dysplasia, which contributes to reduced propulsion and stiffness (Marsden, 2018).

Contralateral Limb – Dogs often offload the affected hip by over-relying on the opposite hind limb. This may predispose the contralateral hip to early degenerative change and increase strain on the stifle joint, particularly the cranial cruciate ligament (Innes & Barr, 1998).

Forelimbs – Increased forelimb loading is a common adaptation. Research using force plate analysis has shown greater peak vertical forces in the thoracic limbs of dysplastic dogs compared with controls (Dycus et al., 2022). This shift may predispose to secondary shoulder or carpal strain, highlighting how distal regions of the body adapt to pelvic dysfunction.

Contribution of Compensatory Strain to Clinical Signs

Compensatory adaptations are often more debilitating than the primary hip pathology itself. Owners may report stiffness in the spine, reluctance to jump, or forelimb lameness, which in many cases are secondary to the compensatory mechanics of hip dysplasia

(Turner et al., 2024). For this reason, focusing solely on the hip joint can be insufficient; a broader musculoskeletal approach is required.

These findings align with the osteopathic principle that dysfunction in one area leads to strain and imbalance in others. Osteopaths view compensatory strain as a predictable but reversible pattern, provided the animal receives appropriate manual intervention (Pusey, Starke, & Coates, 2012). Therefore, understanding compensatory mechanisms is critical in building a rationale for osteopathic treatment in dogs with hip dysplasia.

Summary

Hip dysplasia disrupts the normal biomechanics of the coxofemoral joint, resulting in abnormal loading and widespread compensatory strain. These secondary patterns affect the lumbar spine, sacroiliac joints, contralateral hind limb, and forelimbs, contributing to chronic pain and impaired function. Recognising the full spectrum of these adaptations provides the foundation for a holistic treatment strategy, and it is within this context that osteopathy may offer significant benefits.

Osteopathy in Veterinary Practice

Principles of Osteopathy

Osteopathy is a manual therapy founded on the principle that the body functions as a unified whole, with structure and function being reciprocally interrelated. In human medicine, osteopathy emphasises the body's inherent ability to heal and adapt, using manual techniques to optimise movement, circulation, and neurological function (Pusey, Starke, & Coates, 2012). When applied to animals, the same principles hold true:

musculoskeletal dysfunction in one region may result in compensatory strain and altered biomechanics in distant structures.

Animal osteopathy adapts these concepts to veterinary patients, recognising both similarities and differences in anatomy compared to humans. The focus is not on curing disease, but on restoring mobility, reducing restrictions, and optimising the animal's functional capacity (Marsden, 2018). This is particularly relevant in conditions such as hip dysplasia, where the pathology itself cannot be reversed but where compensatory adaptations may be modulated to reduce pain and improve quality of life.

Techniques Used in Animal Osteopathy

Several osteopathic techniques are applicable to canine patients with hip dysplasia:

Soft Tissue Techniques – Including inhibitory pressure, stretching, and myofascial release. These target hypertonic or shortened muscles that arise as a result of altered gait, particularly in the iliopsoas, hamstrings, and lumbar paraspinals (Marsden, 2018).

Articulatory Techniques – Gentle, rhythmic mobilisations of joints to improve range of motion and reduce stiffness. These may be applied to the sacroiliac joint or lumbar spine, which are commonly restricted in dysplastic dogs (Haussler, 1999).

Functional Techniques – Positioning a joint or region into its position of ease and using subtle movements to encourage the body toward self-correction. This can be especially useful in sensitive or painful dogs where stronger mobilisation would be poorly tolerated (Pusey et al., 2012).

Craniosacral Therapy – Gentle techniques focusing on the cranial and sacral regions, aimed at balancing the autonomic nervous system. Though evidence is limited, practitioners report improvements in relaxation, pain modulation, and systemic balance (Marsden, 2018).

The choice of technique depends on the individual dog's presentation, tolerance, and clinical needs. Importantly, osteopathy is not a replacement for veterinary medicine but a complementary approach that integrates with other therapies.

Current Evidence Base in Veterinary Osteopathy

The evidence base for osteopathy in animals remains relatively limited compared with physiotherapy or acupuncture. However, a growing number of case studies and pilot trials have reported positive outcomes. Haussler (1999) highlighted that manual therapies, including osteopathy and chiropractic, can reduce muscle tension, improve mobility, and support rehabilitation in veterinary patients. More recent studies in canine rehabilitation have demonstrated that manual therapies such as stretching and mobilisation can improve gait quality and reduce pain scores in dogs with musculoskeletal conditions (Dycus, Levine, & Marcellin-Little, 2022).

In horses, where research is somewhat more developed, osteopathic interventions have been shown to reduce spinal stiffness and improve stride length (Lesimple et al., 2012). Although direct extrapolation to dogs must be cautious, such findings support the concept that osteopathy can influence compensatory strain and locomotion in quadrupeds.

Human osteopathy also provides a valuable comparison. Studies in patients with chronic low back pain demonstrate that osteopathic manipulative treatment (OMT) can reduce

pain intensity and improve functional outcomes (Franke et al., 2014). Since dogs with hip dysplasia frequently exhibit secondary lumbar strain, these findings reinforce the rationale for using osteopathy as part of a multimodal approach.

Integration with Veterinary Care

In practice, animal osteopathy is most effective when integrated with conventional veterinary management. Dogs with hip dysplasia may already be receiving NSAIDs, joint supplements, weight management programs, and physiotherapy. Osteopathy complements these by targeting restrictions and strain patterns that are not always addressed by medication or exercise-based therapy (Marsden, 2018).

For example, a dog with unilateral hip dysplasia may present with sacroiliac restriction and contralateral stifle strain. While analgesics may reduce pain, they do not restore mobility to the restricted sacroiliac joint. An osteopathic session, however, may improve mobility, reduce compensatory muscular tension, and enhance the dog's ability to benefit from physiotherapy exercises. This synergistic approach is a hallmark of complementary medicine.

Challenges and Limitations

Despite its potential, veterinary osteopathy faces several challenges. The first is the limited number of peer-reviewed studies, which makes it difficult to draw firm conclusions about efficacy (Pusey et al., 2012). Secondly, outcome measures in osteopathic research often rely on subjective owner reports rather than objective data such as force plate analysis or validated pain scoring tools. However, this gap is gradually

narrowing, as more studies integrate quantitative gait analysis into rehabilitation research (Turner et al., 2024).

Another limitation is regulatory variability. In some countries, osteopathy is well integrated into veterinary rehabilitation frameworks, while in others it remains less formally recognised. This influences availability, collaboration with veterinarians, and research opportunities (Haussler, 1999).

Summary

Osteopathy in veterinary practice applies the same holistic principles as in human healthcare, emphasising the interrelationship between structure and function. Techniques such as soft tissue release, articulatory mobilisation, functional techniques, and craniosacral therapy provide tools for reducing compensatory strain and improving musculoskeletal balance. While research is still emerging, evidence from both veterinary and human literature supports the role of osteopathy as a complementary therapy in conditions such as hip dysplasia. Its integration with conventional veterinary care offers a multimodal approach that addresses not only the diseased joint but also the secondary adaptations that contribute to chronic dysfunction.

Osteopathy & Reducing Compensatory Strain

The Rationale for Osteopathic Intervention

Dogs with hip dysplasia often experience greater disability from compensatory strain than from the primary joint pathology itself. The lumbar spine, sacroiliac joints, contralateral hind limb, and forelimbs all adapt to the abnormal biomechanics of the

dysplastic hip, producing secondary dysfunctions (Comhaire & Schoeman, 2016). Osteopathy directly addresses these adaptations by restoring mobility, reducing muscular hypertonicity, and improving biomechanical balance (Marsden, 2018). This holistic approach provides a strong rationale for integrating osteopathy into the multimodal management of hip dysplasia.

Mechanisms of Osteopathic Influence

Osteopathic treatment may reduce compensatory strain through several mechanisms:

Neuromuscular Modulation – Techniques such as inhibitory pressure, stretching, and functional release influence muscle spindle and Golgi tendon organ activity, reducing hypertonicity in compensating muscle groups such as the iliopsoas and hamstrings (Haussler, 1999).

Improved Joint Mobility – Articulatory mobilisation of the sacroiliac joint and lumbar spine can restore motion to regions that become restricted due to altered gait. Increased range of motion allows more efficient force distribution across the pelvis (Pusey, Starke, & Coates, 2012).

Fascial Release and Circulatory Effects – Myofascial techniques may improve vascular and lymphatic flow in chronically strained tissues, supporting tissue health and recovery (Marsden, 2018).

Neurophysiological Effects – Gentle techniques, including craniosacral therapy, may reduce sympathetic overactivity and improve parasympathetic tone, contributing to relaxation and improved pain modulation (Franke et al., 2014).

Evidence Supporting Osteopathic Application

While specific osteopathy-focused trials in dogs are still limited, growing evidence from veterinary rehabilitation demonstrates the impact of manual therapy on musculoskeletal function.

Hydrotherapy and Laser Therapy: Reusing et al. (2021) reported significant improvements in pain scores, hip extension, and muscle mass in dysplastic dogs treated with hydrotherapy and low-level laser therapy. Although not osteopathy per se, these findings highlight the modifiability of compensatory adaptations through non-invasive interventions.

Vibration Therapy: Turner et al. (2024) found that localised vibration therapy improved mobility and reduced stiffness in dogs with bilateral hip dysplasia, as assessed by owner questionnaires. These results suggest that non-pharmacological interventions targeting secondary strain can enhance function.

Physiotherapy Integration: Dycus, Levine, and Marcellin-Little (2022) reviewed rehabilitation strategies for hip dysplasia and emphasised the role of manual therapies in restoring movement quality and reducing compensatory loading. Their findings strongly align with osteopathic principles, suggesting osteopathy may be particularly beneficial in reducing strain away from the hip joint.

Human Parallels: In humans with chronic low back pain, osteopathic manipulative treatment (OMT) has demonstrated reductions in pain intensity and improvements in functional outcomes (Franke et al., 2014). Given that lumbar strain is a common

compensatory adaptation in dogs with hip dysplasia, these findings provide indirect but compelling support for the osteopathic approach.

Clinical Applications in Dogs with Hip Dysplasia

In practice, osteopathy may be applied to dogs with hip dysplasia in several ways:

Addressing Lumbar Hypertonicity: Dysplastic dogs frequently overuse their lumbar musculature to compensate for restricted hip extension. Soft tissue release of the iliopsoas and longissimus muscles may reduce pain and improve stride length.

Mobilising the Sacroiliac Joint: Restricted sacroiliac motion is a hallmark of chronic compensatory strain. Articulatory techniques can restore mobility and improve propulsion during gait (Haussler, 1999).

Supporting the Contralateral Limb: As the opposite hind limb bears increased load, osteopathy may reduce early strain patterns, potentially lowering the risk of secondary stifle injury.

Balancing Forelimb Overloading: Increased thoracic limb loading often leads to tension in the shoulders and carpal joints. Myofascial release and gentle mobilisation can reduce these patterns, improving overall balance.

Case-based evidence supports these approaches. Marsden (2018) reported improvements in mobility, reduction in compensatory stiffness, and enhanced comfort in dogs receiving osteopathic care for chronic musculoskeletal conditions. While such reports are not controlled trials, they provide valuable clinical insight into how osteopathy may complement veterinary treatment.

Integration with Multimodal Management

Osteopathy is most effective when integrated with a multimodal management plan for hip dysplasia. This often includes NSAIDs for pain relief, weight management, joint supplements, physiotherapy exercises, and in some cases, surgical intervention (Innes & Barr, 1998). Osteopathy adds value by targeting compensatory dysfunctions not addressed by these other methods. For example, analgesics may reduce pain but cannot restore sacroiliac mobility, whereas osteopathy can directly address this.

Furthermore, osteopathy can enhance the benefits of other therapies. Improved mobility from osteopathic treatment may allow dogs to perform physiotherapy exercises more effectively, while reducing compensatory strain may decrease reliance on long-term pharmacological management (Dycus et al., 2022). This synergy underscores osteopathy's role as a complementary rather than alternative therapy.

Limitations and Future Directions

Despite promising clinical reasoning and indirect evidence, robust research specifically on osteopathy in dogs with hip dysplasia remains sparse. Most available literature consists of case studies or extrapolations from human osteopathy and equine manual therapy (Lesimple et al., 2012). Future research should focus on controlled trials using objective outcome measures such as force plate analysis, kinematic gait assessment, and validated pain scoring systems.

Another limitation is variability in practitioner training and technique. Standardisation of osteopathic approaches for veterinary patients would improve consistency and research validity (Pusey et al., 2012). Additionally, greater integration of osteopathy into

veterinary education and rehabilitation frameworks would foster collaboration and increase access for canine patients.

Summary

Osteopathy offers a unique, holistic approach to managing compensatory strain in dogs with hip dysplasia. By addressing neuromuscular, joint, fascial, and neurophysiological mechanisms, osteopathy may reduce secondary dysfunction in the spine, sacroiliac joints, and limbs. While direct evidence in veterinary medicine remains limited, supporting data from rehabilitation studies in dogs and osteopathic research in humans provide a strong rationale for its application. Integrated within a multimodal management plan, osteopathy may enhance mobility, reduce pain, and improve quality of life for dogs living with hip dysplasia.

Conclusion

Canine hip dysplasia is a common and debilitating orthopaedic condition that not only compromises the hip joint but also initiates widespread compensatory adaptations across the musculoskeletal system. These secondary patterns—involving the lumbar spine, sacroiliac joints, contralateral hind limb, and thoracic limbs—often contribute as much, if not more, to the animal's pain and functional impairment as the primary pathology itself (Comhaire & Schoeman, 2016; Smith, Mayhew, & Kapatkin, 2001). Understanding hip dysplasia through a biomechanical and systemic lens highlights the need for management strategies that extend beyond the diseased joint.

Osteopathy, grounded in the principles of structural–functional interdependence and holistic care, provides a complementary approach for addressing compensatory strain. Techniques such as soft tissue mobilisation, articulatory methods, functional techniques, and craniosacral therapy can reduce muscular hypertonicity, restore joint mobility, and enhance systemic balance (Marsden, 2018; Pusey, Starke, & Coates, 2012). Evidence from both veterinary rehabilitation research and human osteopathy supports the view that manual interventions can improve mobility, modulate pain, and reduce secondary dysfunctions (Haussler, 1999; Franke et al., 2014; Turner et al., 2024).

The central question of this thesis—can osteopathic techniques reduce compensatory strain in dogs with hip dysplasia?—finds support in the literature, though direct research remains limited. Studies in canine rehabilitation demonstrate that physical and manual therapies can positively influence gait, reduce pain scores, and improve quality of life (Dycus, Levine, & Marcellin-Little, 2022; Reusing et al., 2021). Case reports and extrapolated findings from human osteopathy reinforce the rationale for osteopathic application in this context. While the underlying dysplastic joint cannot be reversed, compensatory dysfunction can be modified, thereby reducing the animal's overall burden of disease.

The implications for practice are significant. Osteopathy should be considered as part of a multimodal management plan for hip dysplasia, complementing pharmacological, surgical, and physiotherapeutic interventions. By addressing compensatory strain, osteopathy enhances the effectiveness of other therapies, reduces reliance on medication, and contributes to long-term functional outcomes (Innes & Barr, 1998; Dycus et al., 2022). For practitioners, this underscores the importance of interdisciplinary

collaboration between veterinarians, physiotherapists, and osteopaths in supporting canine patients with chronic orthopaedic conditions.

Nevertheless, challenges remain. The limited number of peer-reviewed trials in veterinary osteopathy restricts the strength of current conclusions. Future research should prioritise controlled studies using objective outcome measures such as force plate analysis, validated pain scores, and kinematic gait assessment. Furthermore, standardisation of osteopathic protocols and increased integration into veterinary rehabilitation frameworks will enhance both clinical application and research reliability.

In conclusion, osteopathy holds considerable promise as a supportive therapy for dogs with hip dysplasia. By reducing compensatory strain, osteopathy not only improves mobility and comfort but also aligns with the broader goal of enhancing canine welfare and quality of life. As the evidence base grows, osteopathy may become an increasingly recognised and integrated component of multimodal management strategies for this prevalent and challenging condition.

Bibliography

AKC Staff. (2025, July 30). Hip dysplasia in dogs: Signs, symptoms, treatment. American Kennel Club.

Comhaire, F., & Schoeman, J. P. (2016). Canine hip dysplasia: Pathogenesis, diagnosis and treatment. CRC Press.

Dycus, D. L., Levine, D., & Marcellin-Little, D. J. (2022). Physical rehabilitation for the management of canine hip dysplasia: 2021 update. Veterinary Clinics of North America: Small Animal Practice, 52(3), 719–747.

Franke, H., Franke, J. D., & Fryer, G. (2014). Osteopathic manipulative treatment for nonspecific low back pain: A systematic review and meta-analysis. BMC Musculoskeletal Disorders, 15, 286.

Globaladmin. (2021, February 10). What dogs are prone to hip dysplasia? Global Veterinary Specialists.

Haussler, K. K. (1999). Application of manual therapy in animals. Journal of the American Veterinary Medical Association, 214(8), 1225–1230.

Innes, J. F., & Barr, A. R. S. (1998). Canine osteoarthritis: Pathogenesis and treatment. Journal of Small Animal Practice, 39(11), 447–454.

Kwananocha, I., Bürki, A., Huber, L., Forterre, S., & Schweizer, C. (2023). Acetabular rim extension using a personalized titanium shelf implant in dogs with hip dysplasia. Frontiers in Veterinary Science, 10, 1160177.

Lesimple, C., Fureix, C., Aubé, L., Hausberger, M., & d'Esmé, É. (2012). The effects of osteopathic treatment on spinal mobility in horses. Equine Veterinary Journal, 44(Suppl. 43), 57–61.

Lust, G., & Todhunter, R. J. (1989). Canine hip dysplasia: Concepts and diagnosis. Journal of the American Veterinary Medical Association, 195(9), 1124–1133.

Marsden, J. (2018). Animal physiotherapy: Assessment, treatment and rehabilitation of animals. Wiley-Blackwell.

Pusey, A., Starke, I., & Coates, J. (2012). Animal osteopathy. Elsevier.

Reusing, M. S. O., do Amaral, C. H., Zanettin, K. A., Fritzen, R., & de Souza, M. V. (2021). Effects of hydrotherapy and low-level laser therapy in canine hip dysplasia: A randomized, prospective, blinded clinical study. Veterinary and Comparative Orthopaedics and Traumatology, 34(5), 367–376.

Santana, A. J., Guimarães, J. A., Fonseca, E. S., & Nogueira, G. M. (2022). Early hip laxity screening and the risk of canine hip dysplasia development. Veterinary World, 15(3), 738–746.

Smith, G. K., Mayhew, P. D., & Kapatkin, A. S. (2001). Canine hip dysplasia. Compendium on Continuing Education for the Practicing Veterinarian, 23(2), 100–109.

Turner, K. F., Keegan, R. D., & Cook, C. R. (2024). Client-based evaluation of the effects of localized vibration in dogs with bilateral hip dysplasia. Frontiers in Veterinary Science, 11, 11373568.