

Hip Dysplasia in Dogs: Unraveling the Role of Anatomical Conformation in Pathogenesis and Treatment

¹Sreelakshmi, N.S., ¹Asmin Saji, ¹Haya Fathima, ¹Advaith, R.,

²N.S. Sunilkumar and ³Soumya Ramankutty

¹BVSc&AH graduate students

²Assistant Professor, Department of Veterinary Anatomy

³Assistant Professor, Department of Veterinary Surgery and Radiology

College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

Kerala Veterinary and Animal Sciences University

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Introduction

Canine hip dysplasia (CHD) is a complex and multifactorial orthopedic disorder characterized by a malformed hip joint, leading to osteoarthritis, pain, and compromised mobility. As a pervasive condition impacting a wide array of dog breeds, from the majestic German Shepherd to the playful Labrador Retriever, CHD presents substantial hurdles for veterinarians, dedicated researchers and compassionate dog owners alike. Despite advances in diagnostic and therapeutic approaches, CHD remain a major welfare concern, emphasizing the need for continual research into its genetic, environmental and biochemical underpinnings. This article aims to provide a comprehensive and reader-friendly overview of the current understanding of CHD, delving into its fundamental pathophysiology, advanced diagnostic modalities and a spectrum of effective treatment options, with a keen focus on the pivotal role of anatomical conformation.

Anatomy of the Canine Hip Joint

To truly grasp hip dysplasia, it's essential to first understand the normal, healthy canine hip joint. The hip, or coxofemoral joint, is a classic ball-and-socket synovial joint, exquisitely designed for extensive range of motion and weight-bearing stability. At its core, the joint comprises two main components:

- **The Acetabulum:** This is a deep, concave cavity located within the pelvis. In a healthy dog, the acetabulum is designed to

snugly cup the femoral head, providing a secure and stable socket.

- **The Femoral Head:** This is the spherical, smooth, proximal end of the femur (thigh bone). It fits precisely into the acetabulum, forming the "ball" of the joint.

The stability of this vital joint is further reinforced by several key structures:

- **Joint Capsule:** A fibrous sac that completely encloses the joint, helping to contain the synovial fluid and providing structural integrity.
- **Ligament of the Femoral Head (Ligamentum Teres):** This strong, intra-articular ligament originates from the acetabular fossa and inserts into the fovea capitis on the femoral head. In larger breeds, its pelvic attachment can be more than 1 cm wide, indicating its significant contribution to stability (Evans and de Lahunta, 2013).
- **Articular Cartilage:** Both the femoral head and the acetabulum are covered by a layer of smooth, resilient articular cartilage. This specialized tissue allows for virtually frictionless movement between the bony surfaces and acts as a shock absorber, distributing forces evenly across the joint.
- **Synovial Fluid:** This viscous fluid within the joint capsule lubricates the articular cartilage, nourishes the joint and helps dissipate forces.
- **Periarticular Muscles:** Powerful muscles such as the gluteal muscles (e.g.,

superficial, middle and deep gluteal muscles), iliopsoas and quadriceps femoris group surround the hip joint. These muscles provide dynamic support, aid in joint motion and contribute significantly to overall stability.

- **Acetabular Fossa Fat:** Within and peripheral to the rectangular acetabular fossa, a small quantity of fat is typically present (Evans and de Lahunta, 2013). While its precise functional role in hip stability is still debated, it contributes to the overall joint environment.

The anatomical axes through the femur and os coxae typically meet at the hip joint at a cranially open angle of approximately 95 degrees (Evans and de Lahunta, 2013). This angle is crucial for the optimal biomechanical function of the joint during locomotion.

What is Canine Hip Dysplasia?

Canine Hip Dysplasia is fundamentally a **developmental orthopedic disease**, meaning it arises during the growth phase of a dog. It is characterized by an abnormal formation and development of the coxofemoral (hip) joint, primarily manifesting as **joint laxity** (looseness) and subsequent **subluxation** (partial dislocation) of the femoral head from the acetabulum. This inherent instability inevitably leads to the progressive development of **degenerative joint disease (osteoarthritis)** over time (Schaer and Gaschen, 2011).

In essence, a dysplastic hip can be understood as a ball-and-socket joint where the "fit" is imperfect. The socket (acetabulum) may be inadequately formed, often too shallow, or the "ball" (femoral head) may be misshapen, flattened, or misaligned. The chronic instability and abnormal forces acting upon the joint also frequently lead to the development of bony outgrowths, known as **osteophytes**, around the joint margins (Singh, 2008).

Pathophysiology: The Cascade of Dysplasia

While a puppy's hip joint typically appears anatomically normal at birth, the pathological changes of CHD begin to unfold during the rapid growth phase. The core issue is a progressive loss of congruity between the femoral head and acetabulum (Schaer, 2010). The pathogenesis of CHD is a cascade of interconnected events:

1. **Genetic and Developmental Abnormalities:** CHD is predominantly an

inherited condition, with a complex genetic basis involving multiple genes. This genetic predisposition, often combined with environmental factors (such as rapid growth, excessive weight gain, and inappropriate exercise), leads to abnormal development of both the femoral head and the acetabulum. Instead of forming a deep, congruent socket, the acetabulum may remain shallow, and the femoral head might develop an abnormal shape, flattening, or misalignment, rather than a perfectly spherical form.

2. **Joint Laxity:** This initial developmental incongruity results in an abnormally loose hip joint. The poor "fit" between the femoral head and acetabulum means that the joint capsule and supporting ligaments (like the ligamentum teres) are unable to effectively stabilize the joint. The femoral head does not seat deeply within the acetabulum.
3. **Subluxation (Partial Dislocation):** Due to the inherent laxity, the femoral head moves abnormally and loosely within the shallow socket during weight-bearing and locomotion. This repeated, abnormal movement causes microscopic (and sometimes macroscopic) damage to the joint cartilage and surrounding soft tissues, including stretching or tearing of the joint capsule and ligamentum teres.
4. **Inflammation and Pain:** The repeated trauma and abnormal friction from subluxation trigger an inflammatory response within the joint. This leads to **synovitis**, an inflammation of the synovial membrane lining the joint. Inflammatory mediators cause pain, which manifests as lameness, especially during or after activity. Dogs may exhibit reluctance to move, difficulty rising or a change in gait.
5. **Degeneration (Osteoarthritis/Degenerative Joint Disease):** The continuous abnormal wear and tear on the articular cartilage, exacerbated by inflammation, leads to its progressive erosion and breakdown. The body attempts to stabilize the unstable joint by forming new bone around the joint margins, leading to the development of **osteophytes** (bone spurs). The synovial fluid may also lose its lubricating

properties. Over time, the joint becomes increasingly stiff, chronically painful, and experiences a significant reduction in its normal range of motion, profoundly impacting the dog's quality of life.

Diagnosis of Canine Hip Dysplasia

A definitive diagnosis of CHD relies on a combination of thorough clinical assessment and diagnostic imaging.

1. Physical Examination:

- **Gait Analysis:** Observing the dog's movement at various gaits (walk, trot) and on different surfaces can reveal characteristic signs such as a "bunny hop" gait (both hind limbs moving together), reluctance to run or jump and shifting weight to the forelimbs.
- **Palpation and Manipulation:** Veterinarians will assess for pain on hip extension, abduction and internal/external rotation. They look for signs of decreased range of motion and crepitus (a grinding sensation) within the joint, indicative of cartilage damage and bone-on-bone friction.
- **Ortolani Sign:** This specific maneuver, typically performed under sedation, helps assess joint laxity. A "clunk" sensation indicates that the femoral head can be subluxated from and reduced back into the acetabulum, confirming significant laxity.

Clinical signs often present in two distinct stages:

- **Early Onset (4 to 12 months of age):** Young dogs may show acute lameness, reluctance to play, pain on hip extension, or a "wobbly" hindquarter gait.
- **Later Onset (Over 5 years of age):** Older dogs typically exhibit signs of chronic osteoarthritis, including stiffness, difficulty rising, exercise intolerance, lameness exacerbated by cold or activity, and muscle atrophy in the hindquarters.

2. Radiographic Examination:

- Radiographs are the cornerstone of CHD diagnosis. Standard views include the ventrodorsal (VD) hip extended view (Figure 1). Specialized views like the PennHIP (Pennsylvania Hip Improvement Program) method provide a more objective assessment of hip laxity, even in younger dogs.



Figure 1: Radiograph of normal canine hip

- Radiographic findings indicative of CHD include (Figure 2):



Figure 2: Radiograph of dysplastic canine hip

- **Shallow Acetabulum:** The socket appears flattened and less cupped.
- **Flattening of the Femoral Head (Remodeling):** The "ball" portion of the joint loses its smooth, spherical contour.

- **Subluxation:** The femoral head is visibly displaced laterally or dorsally from the acetabulum.
- **Osteophyte Formation:** Bony outgrowths are evident around the acetabular rim, femoral neck, and femoral head, representing the body's attempt at joint stabilization.
- **Thickening of the Femoral Neck:** A sign of chronic stress and remodeling.
- **Sclerosis:** Increased bone density in areas

Differential Diagnosis

It's crucial to differentiate CHD from other conditions that can cause similar hind limb lameness or gait abnormalities. These include:

- Degenerative myelopathy (a neurological condition affecting the spinal cord).
- Lumbosacral disease (issues with the lower spine).
- Stifle (knee) instability, such as cranial cruciate ligament rupture or patellar luxation.
- Femoral fractures or luxations.

Treatment of Canine Hip Dysplasia

The management of CHD is tailored to the individual dog, considering their age, severity of dysplasia, clinical signs and the owner's commitment. Treatment options broadly fall into conservative (medical) and surgical categories.

Conservative Management (Non-Surgical)

Conservative management aims to alleviate pain, reduce inflammation, slow the progression of osteoarthritis and improve quality of life, especially in mild to moderate cases or when surgery is not an option.

- **Weight Management:** Maintaining an ideal body weight is paramount. Excess weight significantly increases the load on the hip joints, accelerating cartilage degeneration and exacerbating pain.
- **Non-Steroidal Anti-Inflammatory Drugs (NSAIDs):** These medications are foundational for pain relief and reducing joint inflammation. They work by inhibiting enzymes involved in the inflammatory pathway.
- **Pain Modifiers:** Other analgesics like gabapentin or amantadine may be used in conjunction with NSAIDs for comprehensive pain control, particularly in cases of chronic pain.

- **Physiotherapy and Controlled Exercise:** A well-structured exercise regimen is vital. This may include:

- Hydrotherapy (underwater treadmill or swimming)
- Controlled Leash Walks
- Range of Motion Exercises
- Therapeutic Exercises: Specific exercises to strengthen the gluteal and core muscles, which provide dynamic support to the hip.

- **Nutraceuticals (Joint Supplements):** Products containing ingredients like glucosamine, chondroitin sulfate, and omega-3 fatty acids are commonly used. These compounds are believed to support cartilage health, reduce inflammation, and improve joint lubrication.

Surgical Management

Surgical interventions are typically considered for severe cases, young dogs with high potential for future degeneration, or when conservative management fails to adequately control pain and lameness. The choice of procedure depends heavily on the dog's age, severity of dysplasia, and the degree of osteoarthritis present.

- Juvenile Pubic Symphysiodesis (JPS)
- Triple Pelvic Osteotomy (TPO) / Double Pelvic Osteotomy (DPO)
- Femoral Head and Neck Excision (FHNE) Arthroplasty (or FHO - Femoral Head Ostectomy)
- Total Hip Replacement (THR)

Prevention of Canine Hip Dysplasia

While the genetic component of CHD is strong, careful management during the growth phase can significantly reduce the expression and severity of the disease in predisposed individuals.

- **Selective Breeding:** This is the most crucial long-term strategy. Avoiding breeding from affected animals helps reduce the genetic load in the population.
- **Nutritional Management:** High-quality, balanced puppy diets designed for large breeds should be fed to ensure appropriate growth rates, as excessive calcium or calories can contribute to developmental orthopedic issues.
- **Proper Exercise Regulation during Growth:** Controlled, moderate exercise on soft surfaces is recommended to promote strong muscle development without overstressing developing joints.

- **Environmental Control:** Providing non-slip surfaces indoors can help prevent slips and falls that could exacerbate joint instability.

Conclusion

Canine Hip Dysplasia is anatomically characterized by a mismatch between femoral head and acetabulum caused by improper development of bones, cartilage and supporting structures leading to joint instability degeneration and painful movements. Early diagnosis through clinical signs, physical examination and radiographic evaluation is crucial for effecting management. Treatment options range from medical management to surgical intervention depending on the severity. Preventive breeding practices and maintaining a healthy weight are key strategies to reduce the incidence and impact of Hip Dysplasia in Dogs.

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