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A STRUCTURED APPROACH TO ORTHOPEDIC EXAMINATION IN SMALL ANIMALS: A SHORT REVIEW

Eusebiu Viorel ȘINDILAR[1], Alexandra CIUBOTARIU[1]

e-mail: esindilar@yahoo.com

Abstract
A thorough orthopedic examination is essential for accurately identifying and characterizing musculoskeletal disorders in small animals. This short review summarizes the structured approach to orthopedic assessment, beginning with patient history and general physical evaluation, followed by systematic observation at rest, gait analysis, and detailed physical examination. Static and dynamic assessments provide initial localization of pathology, while gait evaluation, including visual analysis and objective force plate measurements, offers critical insight into limb loading and functional impairment. The review also outlines key components of the standing and recumbent orthopedic examination, highlighting palpation techniques, joint mobility testing, and specialized maneuvers such as the Ortolani, Barden, cranial drawer, and tibial compression tests. Diagnostic tools integral to orthopedic evaluation, including radiography, ultrasonography, CT, MRI, arthrocentesis, laboratory testing, and diagnostic analgesia, are discussed in terms of their utility and limitations. This structured, multimodal approach enhances diagnostic accuracy and supports effective clinical decision-making in veterinary orthopedic practice.

Key words: veterinary, orthopedic examination, gait analysis, lameness

A comprehensive orthopedic examination begins with a complete patient history and a general physical assessment, before focusing on the specific musculoskeletal complaint.

The scope and order of the examination vary according to case complexity, trauma history and the animal's use (e.g., breeding, showing, working, or companion). Patients with acute trauma or unstable fractures require stabilization before detailed orthopedic evaluation. In cases of acute trauma, the initial focus should always be on stabilizing life-threatening injuries and preventing further harm. A rapid, primary orthopedic assessment may be performed to identify obvious deformities, open wounds, or limb malalignment while maintaining patient comfort and avoiding manipulation of unstable fractures or dislocations. Definitive orthopedic examination, including manipulation, stress testing, or range-of-motion evaluation, should be postponed until the patient is hemodynamically stable and pain is controlled. This stepwise approach ensures both patient safety and diagnostic accuracy (Denny & Butterworth, 2008; Fossum, 2018; Perry, 2016; Piermattei et al., 2006).

The goal of the orthopedic examination is to identify, localize, and characterize musculoskeletal pathology. According to Perry (2016), the examination can be logically divided into three major phases: observation of the patient in static postures (sitting and standing), dynamic gait assessment and physical orthopedic examination.

MATERIAL AND METHOD

This short review was developed through an extensive literature search performed using the PubMed, Google Scholar, ResearchGate, and Scopus databases. Keywords such as orthopedic examination, gait analysis, lameness evaluation, diagnostic imaging, force plate, and veterinary orthopedics were used to identify relevant peer-reviewed articles, textbooks, and clinical guidelines. Sources were selected based on relevance, scientific rigor, and contribution to current clinical practice. Only publications providing significant insights into orthopedic assessment techniques in small animals were included.

[1] Clinics Department, Faculty of Veterinary Medicine, "Ion Ionescu de la Brad" Iasi University of Life Sciences,Iasi, Romania

RESULTS AND DISCUSSIONS

Observation at rest: sitting and standing

Observation begins before the clinician touches the patient. The animal's behavior while sitting, standing, and changing position provides critical diagnostic clues. The examiner should note:

• Difficulty or reluctance to rise on a particular limb

• Uneven weight-bearing or limb favoring

• Trembling or shifting of a limb

• Malalignment or asymmetry of stance

• Unequal spreading of digits when weight-bearing

These findings help determine which limb or limbs are affected and whether the problem originates from the appendicular skeleton (forelimb, shoulder girdle, hindlimb and its pelvic girdle), axial skeleton (skull, spine, ribs, sternum), or supporting musculature. For example, a dog that rises slowly, shifting weight to the forelimbs and hesitating to extend the hindlimbs, suggests possible hindlimb discomfort. If the hind feet remain wide apart or one thigh shows muscle atrophy, the clinician may suspect pathology in the hip, stifle, or associated soft tissues. Conversely, a stiff, arched back during rising may indicate involvement of the lumbar spine or paraspinal musculature rather than the limb joints.

Gait Assessment

The dynamic phase of the examination aims to confirm which limb or region is affected and to evaluate functional impairment and its degree. The patient should be observed walking on a flat, non-slip surface, and ideally viewed from the front, side, and rear to detect asymmetries in stride length and limb movement. Typical findings include:

• Head nod/bob (1. Usually seen in forelimb lameness because the animal tries to off-weight the affected leg - the head is lowered when the non-affected thoracic limb touches the ground and raised when the affected thoracic limb touches the ground. Observed in slow motion. 2. Rarely can be seen also in severe pelvic limb lameness, because the animal is attempting to shift its body weight forward)

• Hip hike or drop (The patient will try to reduce the amount of weight placed on the affected leg by lifting the pelvis of the affected side, thereby shifting its body weight to the unaffected limb. Difficult to observe in long-haired breeds)

• Shortened stride, circumduction, or toe dragging (neurologic or compensatory causes)

Observation on slopes, stairs, or uneven terrain may reveal subtle abnormalities. Recording the gait on video for slow-motion review or using force plate analysis provides objective quantification of limb loading asymmetry (Duerr, 2020; Gemmill & Clements, 2016; Perry, 2016; Piermattei et al., 2006).

In the orthopedic evaluation of small animals and horses, force plate analysis represents a fundamental objective method for assessing gait and weight-bearing function. A force plate is a rigid platform equipped with load cells or force transducers that record the ground reaction forces (GRFs) generated by an animal's limbs during stance (Carr, 2016; contributors, n.d.; van der Zande, 2020). This technology allows clinicians to precisely measure how much load each limb bears—expressed as peak vertical force (PVF) and vertical impulse—and to evaluate the symmetry of limb loading between contralateral limbs (Carr, 2016; Tuchpramuk et al., 2025). Because it provides quantifiable data on limb function, force plate analysis has been described as the optimum approach to objective gait evaluation in veterinary practice (Carr, 2016).

During the orthopedic examination, the animal is walked or trotted across a walkway containing one or more force plates at a controlled velocity, ensuring accurate limb contact and repeatable data collection (Carr, 2016). The recorded parameters, including peak vertical force (the maximum load exerted during stance) and vertical impulse (the area under the force–time curve), provide an objective assessment of each limb's contribution to locomotion (Tuchpramuk et al., 2025). Derived indices, such as asymmetry ratios, are valuable in detecting subtle lameness or altered limb loading patterns that may not be visible during routine observation (Brown et al., 2013). Research has also demonstrated the method's clinical utility—for instance, in evaluating postoperative recovery and hind-limb weight-bearing following orthopedic surgery such as femoral head and neck excision (Tuchpramuk et al., 2025).

Before evaluating gait abnormalities, it is essential to understand normal canine locomotion. The dog's ambulatory motion has been described to consist of up to seven different gait patterns: walk, trot, pace, amble, canter, transverse and rotary gallop. However, 4 are primary: walk, trot, canter, and gallop (Carr, 2016).

Gait patterns are classified by their beat, the presence of a suspension phase, and whether they are lateral or diagonal. The beat refers to how many times the feet contact the ground in one stride — for example, the walk is a four-beat gait because each limb touches the ground at different time points within the stride cycle. A stride refers to one complete cycle of limb movement; from the moment a particular foot touches the ground until it contacts the ground again. The suspension phase occurs when no feet are on the ground, seen only in faster gaits like the trot and canter. In diagonal gaits, opposite front and hind limbs move together (as in trotting), while in lateral gaits, the limbs on the same side move together (as in pacing) (Duerr, 2020).

The walk is a slow, four-beat gait with no suspension phase, meaning at least one paw is always on the ground. The amble is basically a faster walk, keeping the same four-beat pattern. The trot is a two-beat, diagonal gait with suspension phase. The pace is also a two-beat gait, but same-side (ipsilateral) limbs move together instead of diagonally. The canter is an asymmetric gait. The gallop is the fastest gait a dog uses. Although there has been some debate about whether the pace is a normal or abnormal gait, it has been observed in dogs without any evident orthopedic disorders (Duerr, 2020).

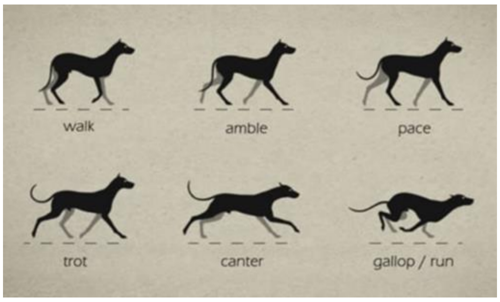

Figure 1 – Gait patterns in dogs
(Van Evra, 2020)

The walk, amble, and pace share the same basic pattern: first, a hind limb moves forward, followed by the forelimb on the same side. The pattern then repeats on the opposite side. The main difference among them lies in how soon the forelimb lifts after the hind limb has moved. In the walk, the forelimb lifts at the last moment, just as the hind limb lands. The dog moves forward almost one leg at a time, producing a slow, stable four-beat gait. When stalking, the dog may use a halting walk, allowing it to stop movement instantly and remain motionless. In the amble, the forelimb lifts slightly earlier — during the forward swing of the hind limb. This gait serves as a transition between walking and pacing. In the pace, the forelimb lifts at the earliest possible moment, nearly in synchrony with the hind limb on the same side. Both legs swing forward together and land simultaneously. Pacing provides good traction for a tired dog or when pulling a load.

In the trot, diagonally opposite legs move together (for example, right forelimb with left hind limb). A dog trots when it is moving at a moderate speed, typically faster than a walk but slower than a gallop; when a dog is traveling faster than a walk, it will naturally transition to a trot for efficiency. The canter is the only 3-beat gait. It is used for long distances as it's smooth and helps the dog conserve energy. It begins when one hind limb pushes off, followed by the simultaneous action of the opposite hind limb and forelimb, and ends when the remaining forelimb completes the stride. In the gallop, the hind limbs act as a pair, with one leg following the other in quick succession, while the forelimbs follow a similar alternating pattern. A suspension phase occurs when all four feet are off the ground during the contraction phase of the stride. Some dogs display a second suspension during the extension phase, producing the so-called double suspension gallop. However, many breeds are not anatomically adapted to achieve this motion.

Physical orthopedic examination

The physical orthopedic examination is an essential part of the diagnostic process. It requires a methodical and systematic approach, beginning with general observation and progressing to detailed palpation and manipulation of specific regions.

1. Anamnesis

Before performing a specific orthopedic examination, it is important to obtain a complete history of lameness, including previous diagnostic tests (radiographs, other imaging, laboratory work), previous treatment attempts and their outcomes. The owner’s goals for their pet, any other systemic diseases, travel history, vaccination and preventive medication records, diet, and any supplements administered should also be noted. In addition, information about the onset, timing, possible causes (such as trauma, exercise, or rest), and progression of lameness is valuable for narrowing the diagnosis. Soft tissue injuries usually improve or resolve within several days, while chronic, progressive lameness is more likely related to conditions such as arthritis or neoplasia. If the lameness is worse in the morning or after periods of rest, this may indicate a degenerative disease. A lameness that improves with exercise is often associated with chronic soft tissue injury or osteoarthritis, whereas one that worsens with activity is more likely due to neurologic disease or neoplasia.

2. General physical assessment

Before concentrating on the musculoskeletal system, the clinician must perform a complete physical examination to identify systemic or neurologic conditions that may contribute to gait abnormalities. Parameters such as temperature, pulse, and respiration should be recorded; pyrexia may indicate septic arthritis, osteomyelitis, or systemic infection. The neurologic status should also be briefly assessed—checking for proprioceptive deficits or spinal pain (Fossum, 2018; Piermattei et al., 2006).

In general, a combination of standing and recumbent positions provides the most effective evaluation. The contralateral limb must be compared to determine whether observed findings are physiological or pathological, but always consider that many disorders occur bilaterally (best accomplished during a standing examination). The recumbent position is required for specific orthopedic tests and facilitates a more detailed palpation of the affected limb. Every orthopedic examination should incorporate certain neurologic assessment elements, including paw replacement, paraspinal palpation, tail lift, and neck range of motion.

3. Standing examination

Begin examination by approaching the patient calmly and placing your hands gently on their body to familiarize them with your presence. The technician should provide appropriate restraint while the owner reassures the dog from the front. Balance the patient's position before starting palpation.

Maintain gentle contact with your body against the patient's side so they are aware of your position. Start the examination with a systematic palpation of the spine, using gentle but thorough movements. Assess the thoracic and lumbar regions for pain, muscle spasm, or abnormalities by palpating the paraspinal muscles. Identify anatomical landmarks such as the pelvis, lumbosacral junction, and tail base, performing a tail jack if necessary. Lifting the tail cand exert a pain response that indicates lumbosacral disease.

Pelvic limb examination

Beginning the orthopedic examination with palpation of the pelvic limbs allows the examiner to remain safely positioned away from the animal's front, enabling an initial assessment of the patient's demeanor in a controlled manner. The first step is to evaluate proprioception in both pelvic limbs using the paw replacement test. Next, simultaneous palpation of both pelvic limbs helps detect any muscle asymmetry, masses, or soft tissue swelling. The tarsus and stifle joints should also be examined for signs of joint effusion.

With appropriate support, begin mobilizing the pelvic limb, sequentially assessing the hip, knee (stifle), and hock joints. Observe the patient's reaction for signs of discomfort or restriction of motion.

Flex and extend each joint (Figure 2), assessing range of motion, pain response, and joint stability. Continue palpating the femoral, tibial and metatarsal bones to identify any areas of bone pain.

Examine the stifle joint through a full range of motion, including full flexion and extension. Evaluate for internal rotation, patellar instability and joint effusion. Assess stability by performing both the cranial drawer test and the tibial thrust test. These tests can be conducted with the patient standing or, in certain cases, in lateral recumbency for improved relaxation and control.

The hock joint should be flexed, extended, and palpated in both positions to assess stability. Replace the foot on the ground to evaluate the Achilles mechanism, ensuring there is no thickening or irregularity.

When continuing distally, examine the phalangeal and metatarsophalangeal joints for any thickening, fibrosis, range of motion or other abnormalities.

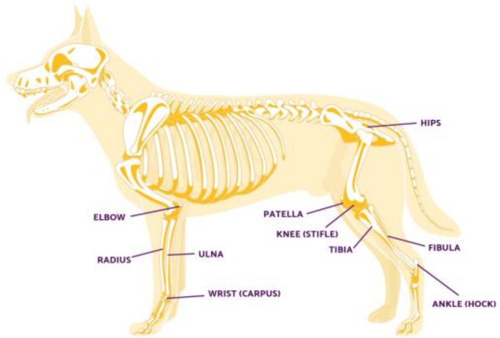

Figure 7 – Anatomical landmarks and major joints of the dog (Ortho Dog, 2025)

As you progress forward, cranially, along the patient, maintain close body contact. Straddling the patient can provide better control of posture and prevent sitting. When examining the cervical spine, assess motion in all four directions (ventroflexion, dorsoflexion, and lateral movements) and palpate each vertebra to detect localized pain or abnormalities.

Thoracic limb examination

Palpation of the thoracic limb begins with the shoulder joint, assessing both extension and flexion. Perform pronated flexion to assess the medial aspect of the shoulder joint under stress. Continue with the elbow joint, checking for smooth range of motion in both flexion and extension. Move distally to examine the carpus. The carpus should be evaluated in both flexed and extended positions. Continue flexing and extending each joint, including all digits like in the hindlimb. Assess for joint pain, abnormal thickening, or long bone irregularities.

4. Recumbent Examination

The patient is then positioned in lateral recumbency, and each limb is examined from distal to proximal, leaving the most painful or affected limb for last. Palpate major bony landmarks for symmetry: the acromion, greater trochanter, ischial tuberosity, iliac crest, and medial malleolus. Palpation assesses heat, swelling, pain, crepitus, instability, and range of motion. Each joint should be moved through its normal physiological range, noting any restriction, pain, or abnormal laxity. For this, some special tests can be done (Perry, 2016).

Special tests include:

A. Ortolani and Barden signs for coxofemoral laxity (hip dysplasia screening). Both performed with the patient sedated for reliable results. Palpating for hip laxity is standard for hindimb lameness in dogs, but is usually detectable in dogs younger than 2 years, before fibrosis sets in.

The Ortolani test is a physical examination used to check for hip laxity, a key sign of hip dysplasia in young dogs. The test involves manipulating the dog's hind limbs to see if the femoral head subluxates (slides out of the hip socket) and then reduces (clicks back into place), which is considered a positive Ortolani sign. (Fry & Clark, 1992).

The Barden sign is assessed by placing one hand over the greater trochanter while the other hand grasps the femoral diaphysis. The examiner then lifts or levers (adducts) the femur laterally to attempt elevation of the femoral head from the acetabulum. A lateral displacement of the greater trochanter exceeding one-quarter inch is considered a positive Barden sign, indicating hip joint laxity (Montgomery, 2011).

B. Cranial drawer and tibial compression tests for cruciate ligament rupture

For the first test, the femur and tibia are stabilized with each hand and the tibia is gently moved cranially relative to the femur. Excessive forward motion (“drawer sign”) indicates a ruptured or lax cruciate ligament (Lampart et al., 2023).

Tibial compression (tibial thrust) test represents a dynamic alternative to the drawer test for cruciate evaluation. With the stifle held in slight flexion, compress the metatarsus; cranial movement of the tibial tuberosity relative to the patella indicates cranial cruciate rupture (Might et al., 2013; Perry, 2016).

C. Collateral stability tests for carpal, tarsal, or elbow collateral ligaments.

With the joint held in extension and again in flexion, apply valgus (slight lateral) and varus (medial) stress. Increased motion or soft end feel compared to the contralateral limb indicates collateral ligament injury (Duerr, 2020).

D. Patellar tracking assessment for luxation or malalignment. Patellar luxation is a common orthopedic condition in dogs, with medial luxation occurring more frequently than lateral, particularly in small-breed dogs.

The stifle is flexed and extended while applying medial and lateral pressure on the patella. Displacement or a tendency for the patella to deviate out of the trochlear groove suggests luxation (Di Dona et al., 2018).

The examination should conclude with a clear localization of pain and a list of differential diagnoses, guiding further diagnostic testing and treatment planning.

5. Diagnostic Tools

5.1. Radiography

Radiography remains the primary imaging modality in small animal orthopedics. Standard orthogonal projections (two views at 90° angles) are required for accurate interpretation. Proper positioning, exposure, and inclusion of adjacent joints are critical. Radiographs reveal fractures, subluxations, periosteal reactions, osteolysis, osteophytes, and degenerative joint changes. Comparative views of the opposite limb are often valuable for subtle lesions (Allan & Davies, 2018). Although modalities such as CT, MRI, and ultrasound provide more detail for soft-tissue evaluation, radiography remains the cornerstone for initial orthopedic assessment and for monitoring healing or progression of skeletal disorders.

Ultrasonography provides real-time evaluation of tendons, ligaments, and joint effusions in small animals, detecting fiber disruption, hypoechogenicity, and synovial thickening. Its diagnostic accuracy depends on operator skill and transducer positioning, making it a valuable, noninvasive tool for musculoskeletal assessment, though less effective for deep intra-articular or osseous lesions (Karatrantos et al., 2025; Kramer, 2004).

5.2 Advanced Imaging

Computed tomography (CT) provides excellent cortical bone detail and is useful for complex fractures, elbow dysplasia, and bone tumors. Magnetic resonance imaging (MRI) is superior for evaluating soft tissues, articular cartilage, and spinal lesions (Duerr, 2020; Greco et al., 2023). However, the use of nuclear medicine in veterinary practice remains limited due to high costs, strict regulations, and the need for specialized training, despite its availability in some academic institutions.

5.3 Arthrocentesis and Laboratory Tests

Synovial fluid analysis is indicated for suspected arthritis or infection. Normal fluid is clear, viscous, and of low volume, whereas pathologic samples are turbid, less viscous, and contain increased nucleated cells. Bacterial culture and cytology help distinguish septic from immune-mediated arthritis. Hematology and biochemistry may show systemic inflammatory responses such as leukocytosis, neutrophilia, or elevated acute-phase proteins (Fossum, 2018; Piermattei et al., 2006).

5.4 Diagnostic Analgesia

Regional or intra-articular anesthesia can assist in localizing pain when imaging is inconclusive, particularly in athletic or working dogs. Sequential nerve and joint blocks with gait re-evaluation confirm the pain site. These diagnostic blocks are typically performed using aseptic technique with local anesthetics such as lidocaine or mepivacaine, targeting specific joints or periarticular nerves based on clinical suspicion. A positive response (marked improvement or resolution of lameness) aids in confirming the anatomical location of pathology and also guide further diagnostic imaging and therapeutic decision-making (D. Van Vynckt, 2012; Duerr, 2020; Perry, 2016).

CONCLUSIONS

A systematic and comprehensive orthopedic examination remains fundamental to the accurate identification and characterization of musculoskeletal disorders in small animals. By combining structured clinical observation, detailed gait assessment, meticulous palpation, and the judicious use of diagnostic imaging and ancillary tests, clinicians can achieve a more precise localization of pathology and improve diagnostic reliability. This integrated approach enhances clinical decision-making and supports veterinarians in delivering timely, effective, and evidence-based orthopedic care.

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