What About Gait Analysis in Clinical Settings?

Janet Steiss, DVM, PhD, PT
and Victoria Light

College of Veterinary Medicine,
Auburn University, AL, 36849

Assessing outcome through gait analysis is useful in the current evidence-based practice environment. There is a need to evaluate the effectiveness of rehabilitation interventions for dogs, such as therapeutic exercise, electrical stimulation, ultrasound, shock wave therapy, balance training, and surgical versus medical treatments.

In the research laboratory, motion analysis systems, force plate technology, and electromyography have provided detailed pictures of quadruped gait. However, the cost-benefit ratio can be high in a clinic setting. Much of this technology is labor intensive, time-intensive, and too expensive for clinical use.

Other more practical options for gait analysis of canine patients are available. Some of these include:

Visual Observation. This is the first step in evaluation. With experience, clinicians can become proficient at observation. However, this assessment is not objective, and inter-rater variability exists. Clinical gait analysis is seldom taught as a component in veterinary curricula. Veterinary orthopedic surgeons often grade lameness using a 5-point scale. For humans, numerous grading scales to address specific gait disorders have been validated, but are not available in veterinary medicine at this time.

Visual Observation of Videotape.

Pros:

• Video tape can be viewed repeatedly, including slow motion or stop-frame

Handler with Border Collie walking on a portable electronic walkway *(GaitRite/GaitFour, CIR Systems, Inc)*. The 16 foot length allows recording of 4 or more consecutive gait cycles per pass across the mat.

• Relatively inexpensive technology

• Serial recordings allow for comparisons over time

Cons:

• Not quantitative

Electromyography (EMG). The measurement of electrical activity of muscles. EMG uses surface electrodes or fine wire electrodes inserted into specific muscles.

Pros:

• Allows analysis of timing of specific muscle activation

• Allows quantitative analysis of the electrical discharges of specific muscles

Cons:

• Does not correlate directly with muscle force

• Electrodes record cross talk from adjacent muscles
• More often combined with kinetic or kinematic data rather than EMG alone (e.g., EMG with kinematics for detailed study of stifle motion after surgical repair of ruptured cranial cruciate ligament)

Kinetics. The analysis of forces.

A. Force Plate: The measurement of floor reaction forces. Force plate analysis has been widely accepted in the veterinary field.

Pros:

• Quantitative data on vertical and horizontal ground reaction forces, medial-lateral forces, etc, during stance phase

• No instrumentation is applied on the dog

Cons:

• Relatively expensive

• Requires dedicated laboratory space for installation of one or more force plates

• Speed needs to be controlled within a precise range

• Requires multiple passes across the plate for sufficient data from each limb

B. Pressure Mat: Recording of paw pressure as the dog walks over the mat. Reports pertaining to dogs studied with this technology are limited at this time.

Pros:

• Measures multiple consecutive gait cycles, depending on mat length and stride length

Cons:

• Transducers tend to be non-linear and require consistent calibration

Kinematics (2-D and 3-D). The analysis of the motion of various body segments. Examples of measurements include joint flexion and extension angles, angular velocity, etc. High speed motion analysis is preferred.

Pros:

• Allows detailed analysis of individual joint motion

• Allows analysis during various activities, (e.g., walking uphill, jumping, walking in underwater treadmill)

• Analysis could provide better tailoring of exercise prescriptions of specific joints

• 2-D recordings can be sent to an off-site laboratory for analysis

• Numerous software programs are commercially available

Cons:

• Markers on skin may move during motion

• Time factor required to apply markers prior to recording

• 2-D analysis is usually limited to the sagittal view recorded with one camera (it is assumed that all motion is in a plane perpendicular to the camera axis, which is unlikely, and marker movement outside the plane is distorted)

• 3-D analysis is expensive in terms of cameras [requires minimum of 2 cameras (preferably 4), expert personnel to handle the complex hardware and software set-up, and dedicated laboratory space]

• Analysis requires breed specific normative data (e.g., hind limb kinematics of the Greyhound vs. German Shepherd)

Electronic Portable Walkway (Gait Mat). Electrodes are embedded along the length of a flexible mat. This method provides temporal and spatial data (e.g., stance time, stride length, cadence, velocity). Improvements in sensor density and scan rates have resulted in increased spatial and temporal resolution. Reports pertaining to dogs studied with this technology are limited at this time.

Pros:

• Outcomes such as speed, step-to-step variability, and symmetry ratios are simpler descriptors that may be more relevant functional outcome measures

• Portable

• Allows comparison of all 4 limbs over sequential gait cycles

• No instrumentation is applied on the dog

• Mid-price range

• Lends itself to performing screening tests (more global approach that can be followed up with specific diagnostic evaluations)

• Automated paw identification minimizes operator training

• Raw data files can be edited

Cons:

• Requires level floor surface (can be placed on sloped surfaces or under cavaletti, etc)

• Space requirements depend on length (e.g., 16 ft mat plus 6 ft dead space on each end)

Combined Systems. Kinematics can be combined with force plates and EMG to provide a comprehensive analysis of muscle activation, torques, and joint positions, for example. However, in a clinical setting, such a highly instrumented approach may not yield the most relevant functional information. The choice belongs to the clinician to determine how to incorporate gait analysis for their specific clinical needs.

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