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Pressure mats

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The locomotion of animal has been a passion for scientists from antique to now (Pline, Xenophon, and later Borelli, Bourgelat, Marey or Muybridge) particularly for quadrupeds as the horse or the dog. First, gait was evaluated by observation or hearing, with the development of recording and measuring devices the gait can now be qualify and quantify and many gait parameters have been proposed to define the normal and abnormal gait of human and animals. Many gait analysis systems have been developed. Kinematics systems are able to describe motion regardless of the influences of mass and force acting while kinetic systems are able to study the relationship between motion and the force related to it. They are complementary systems. The main kinematics systems able to characterize temporal and geometric parameters are picture video system 2D, footswitches, pressure walkways or mats, electro-goniometers and video motion analysis. Kinetics devices are forces sensors, force shoes and force plates.

Among all this devices, for our clinical biomechanical lab, we have chosen three systems to analyse the gait of dogs: Electro-goniometer and surface EMG, 2D video motion system and pressure walkway system. Pressure mats have been used in research and clinical practice. Many pressure mats are available on the market: the Gait rite system, the RSscan, Tekscan Walkway™ System and Gait mat. They differ in length, frequency acquisition, resolution and analysis software.

In 2004 we have developed an original software for the Gait rite Gold system to analysed the quadruped locomotion. The new Platinium GaitRite® system (CIR Systems, Inc.) is a 4.2 to 8 meters long portable walkway, which has 7 to 10 sensor pads containing each 2456 sensors measuring spatiotemporal aspects of gait. The spatial resolution of the device is 1.27*0.82 cm and the sampling frequency is 100 to 240Hz. This system collects spatio-temporal and pressure data: time and location of footprints, pressure and number of sensors activated during the stance.

The extrapolated spatial parameter was the stride length (cm) measured between the heel points of two consecutive footprints of the same foot (left to left, right to right).

The extrapolated temporal parameter included:

- the stance time (s) measured between the first and the last contact of the same footprint
- the stride time (s) was the time elapsed between the first contacts of two consecutive footfalls of the same foot
- the relative stance time (% of cycle) was presented as a percentage of the gait cycle time (stance time/stride time)
- the cadence, also called stride frequency (strides/s) was the number of strides during one second.
- the walking velocity

Extrapolated kinetic parameters were peak pressure (maximal of pressure during stance) mean of pressure and number of activated sensors.

In addition to the data/parameters collected directly by GaitRite®, we calculated fore limb versus hind limb ratios and symmetry for left/right limbs; left/right fore limbs; left/right hind limbs. This function is presently in the new software.

This validated system was proved to provide useful data: spatiotemporal parameters, maximal pressure and number of activated sensors of the normal dog and pathological dog at walk, trot, jump or descent of stairs; and allowed quick analysis as well in research as in clinical practice.

The sensitivity and specificity are very good for principle lameness in dogs.

Is the force plate still a gold standard?

As others systems force platforms aim mainly to capture sensitive and reliable data: the 3 resultant axis ground reaction forces (peak vertical and horizontal forces, vertical impulse, acceleration, symmetry, etc). They were used to assess locomotion after a treatment or a surgical procedure in the majority of published biomechanical studies. Nevertheless force platform presents several limits. The system would be complex, hardly portable and required some specific environment and conditions of use. Moreover, data could not be collected from all four limbs during one cycle using a single force platform. Consecutive strides could not be assessed without an associated treadmill. Several trials are necessary to obtain correct placement of the foot on the plate. Moreover to perform a comparison between each side, it’s necessary to have at least 2 trials in the same conditions of speed and acceleration of the dog, which is hardly feasible and requires many trials and time with a very quite dog. Even with an appropriate room and floor, the dog as well as old person may feel a different stance between the ground and the force plate and might interfere with the collection of reliable data.
Because of those limits, gait mats have been developed for the human gait analysis. Now they could be used in association with an accelerometer or a 2D video kinematics system according to the manufacturer. Presently they seem to give more information of the gait balance of the dog during locomotion. This concept may be easiest to understand for a practitioner or a non-engineer rather than kinetics. The walkways systems even if they are recent and not well known, are easier to use and quicker to analyze and no less reliable than force plate systems with multiple measurements of forces with no identical experimental conditions.

REFERENCES