Uncovering Objective Gait Insights, from Paw to Claw

Showcasing Applications and Opportunities for Low-Profile Pressure Measurement Technologies in Veterinary Research and Animal Science

Tekscan™

Table of Contents

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Insightful Technology that Helps Animals Talk with Their Walk

Spoken word is just one of many ways that humans communicate with one another. **We are instinctively clued-in to observe visual cues that can suggest how an individual is feeling and their mood.** Anything from posture to eye contact are important non-verbal actions that can speak volumes about a person in a specific moment.

Animals are similar to humans in these instinctual, visual cues they use to express themselves. While they lack the ability to speak a language, animals of the same species (and possibly across different species) often rely on physical movements and actions to communicate with one another. Along with the waggle of a tail, perk of their ears, or a ruffle of feathers – **an animal's gait is an important and measurable display of their state of being.**

However, visually identifying abnormalities of an animal's gait is still only telling part of their story. There are certain nuances that can indicate potentially serious issues that may not be as clearly identifiable by the naked eye. **With the help of innovative gait analysis technologies, veterinarians and researchers can more effectively decipher what an animal is trying to communicate with each step that they take.**

Modular, low-profile, pressure-sensitive walkways provide objective information that identifies problem areas and asymmetries, which can be used to assess, help treat, and gauge treatment effectiveness over time. Objective data provides the ability to determine precisely which paw or limb is problematic, allowing for an easier method to monitor progress.

With multiple resolutions available, nearly any size bipedal or quadrupedal animal can be evaluated – from rats, to turkeys, to cows.

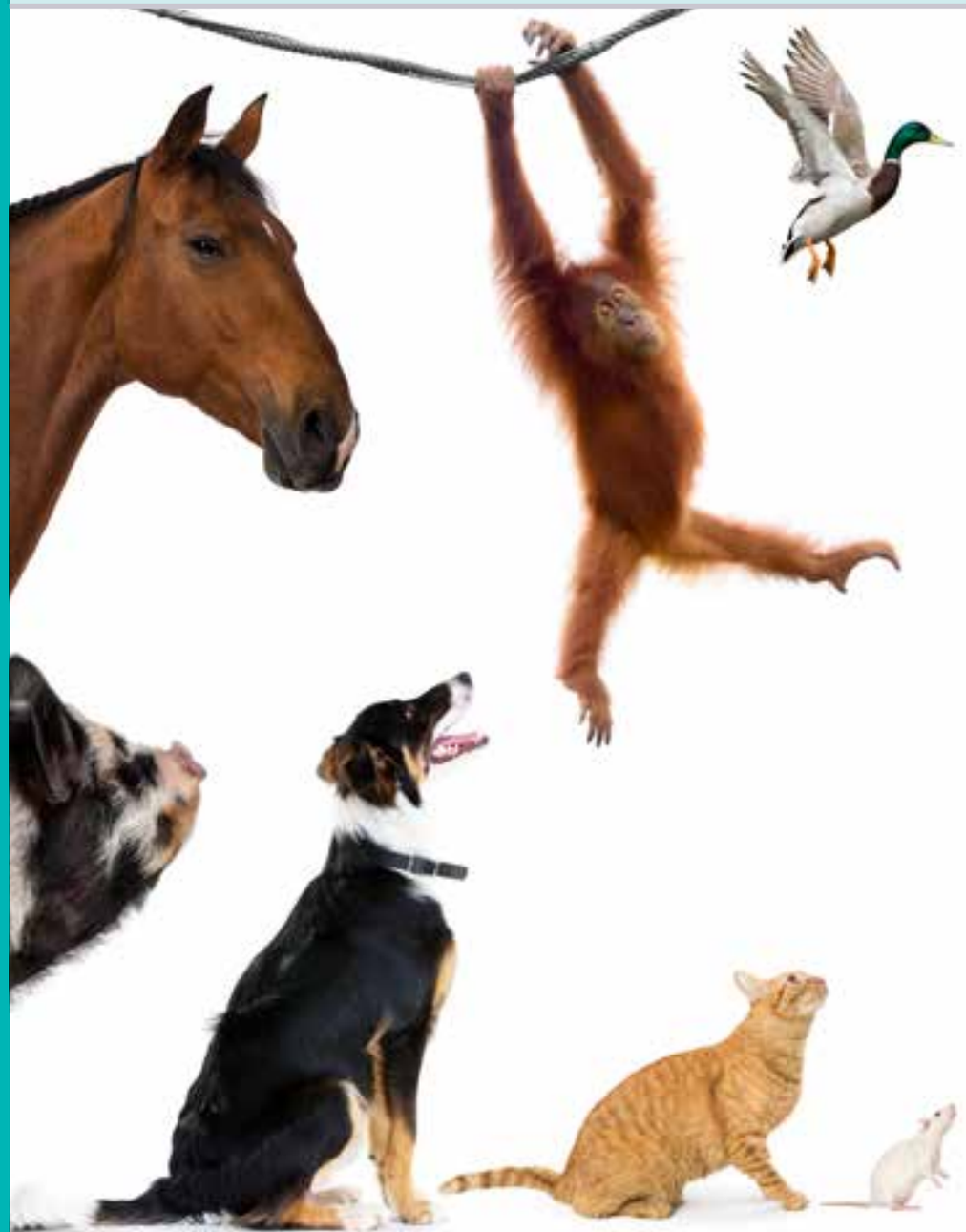
This eBook will share several real-world research examples of how Tekscan gait analysis systems have been used by veterinarians to more accurately assess paw and hoof function.

How Tekscan Technologies Have Been Used in Animal Gait Research

Gait analysis is a broad term that covers any technique for analyzing walking or movement patterns. While there are a number of forms and methods for gait analysis, those involving technology will provide data that traditional observation cannot. Even for experienced professionals, observational gait analysis provides limited insights.

Having quantifiable gait analysis data is especially important when working with animals. Because they cannot articulate their pain, or effect of an adjustment to their treatment, veterinarians and researchers must place a lot of trust in the data.

The illustration on the right shares just a few examples of how actionable gait analysis tools from Tekscan can help uncover important insights.



- **Orthopedic Disease Discovery**
- **Lameness Assessment**
- **Pharmacology Testing**
- **Kinetics & Kinematics**
- **Jumping Assessment**
- **Flooring Design**

ANIMAL GAIT ANALYSIS SYSTEMS

Tekscan systems provide objective information to identify problem areas and asymmetries, treat, assess, and monitor treatment effectiveness. Learn more about our wide variety of solutions for animal gait analysis and paw/hoof function assessments.

HIGH-RESOLUTION WALKWAY

Higher resolution makes it possible to capture gait analysis for light-weight animals, including rodents and birds.

Learn More!

ANIMAL STRIDEWAY™

Modular pressure measurement walkway ideal for dogs, cats, and animals of similar sizes.

Learn More!

HOOF SYSTEM

Measure gait and ambulatory function of large, hooved animals.

Learn More!

What Does Tekscan Technology Add to Visual Gait Analysis?

Visual gait analysis only looks at the motion of the gait cycle, not the force or weight distribution. This means subtle asymmetries can easily be missed. Advanced gait analysis solutions, such as the ones shown on the left, will provide objective data for your research.

- **Validate Drug Efficacy During Development Processes:** Establish baselines, and monitor changes in gait performance with quantifiable data that visual observation lacks.
- **Confirm New Surgery Techniques:** Evaluate the effectiveness of treatment, and help diagnose potential asymmetries and other abnormalities following surgical procedures.
- **Verify New Rehab Processes and Techniques:** Track the patient's progress through a treatment program, helping to determine next steps.

Animal Gait Analysis Research Examples

Pictured: Animal Strideway

Image courtesy of the Korean Research Institute of Bioscience & Biotechnology (KRIBB) National Primate Research Center

Orthopedic Disease Discovery

CITATION: Aristizabal Escobar, A. S., et al "Kinetic Gait Analysis in English Bulldogs" (2017) Acta Veterinaria Scandinavica. 59:77 DOI 10.1186/s13028-017-0344-6

Background: English Bulldogs are particularly susceptible to conformational disorders. Lameness or limited limb function may manifest in a variety of clinical signs, ranging from subtle gait changes to limb function compromise.

Thirty English Bulldogs were studied for their vertical forces while walking. A **High-Resolution Animal Walkway System** was used to help researchers evaluate:

- Peak vertical force
- Vertical impulse
- Rate of loading
- Stance phase duration
- Symmetry index
- Goniometry, and
- Incidence of orthopedic diseases

Results: While none of the dogs showed signs of pain or discomfort, all dogs had radiographic evidences of hip dysplasia and lack of significant peak vertical force, vertical impulse, and stance time differences.

- The examined dogs had a mean hind limb symmetry index of 19.8 ± 19.5%, and
- Their rates of loading ranged from 1.0 to 3.1.

With the help of the High-Resolution Animal Walkway, the researchers determined that the Bulldogs did have gait dysfunctions, despite no visible signs in their gait function, nor any discernible discomfort shown by the animal.

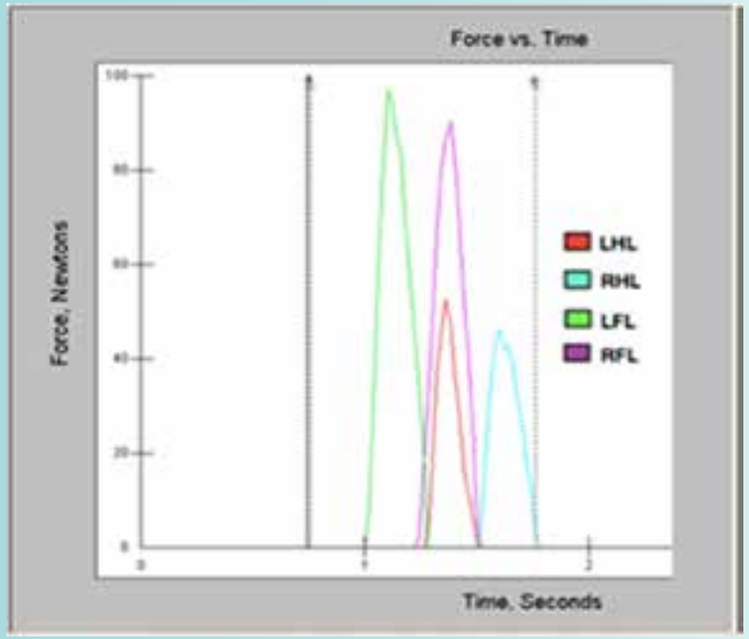


Figure 1
Vertical force graph generated from one valid passage. "HL" indicate the dog's hind legs, while "FL" indicates the dog's front legs.

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Lameness Assessment

CITATION: Sheldon JD, Adkesson MJ, Allender MC, Bailey RS, Langan JN, Chinnadurai SK (2019) "Evaluation of a pressure sensitive walkway for objective gait analysis in normal and arthritic domestic ducks (Cairina moschata domestica)." PLoS ONE 14(7): e0220468.

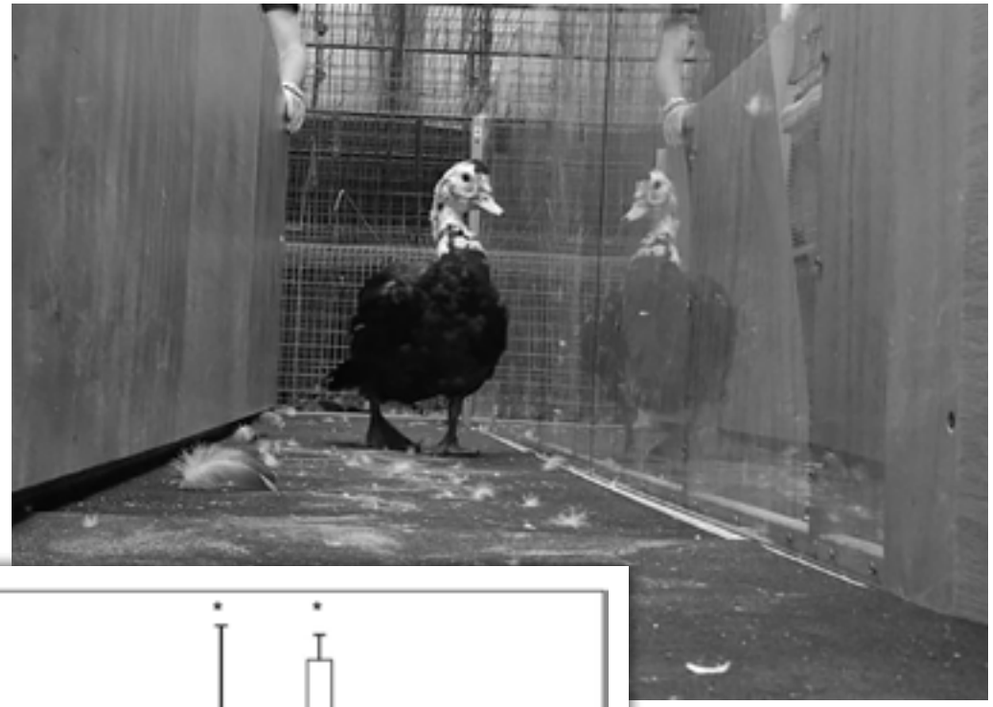
Background: Objective gait analysis of birds with lameness due to pododermatitis, osteoarthritis, and other common diseases, could provide a non-biased assessment and therapeutic monitoring for zoo clinicians. The researchers used the **High-Resolution Animal Walkway System** to study 18 healthy adult ducks (mean body weight of 2.25 kg) in two experiments.

Experiment 1:

- All 18 ducks were evaluated for their gait parameters (step and stride distances and velocities, maximum force, impulse, and peak pressure).
- Each duck was encouraged to walk down the Walkway at least four times.

Experiment 2:

- Six of the ducks were randomly selected, anesthetized, and administered a unilateral intra-tarsal injection of monosodium urate (MSU) solution to induce arthritis.
    - Serial trials were repeated at 1, 2, 3, 4, 8, and 24 hours post injection



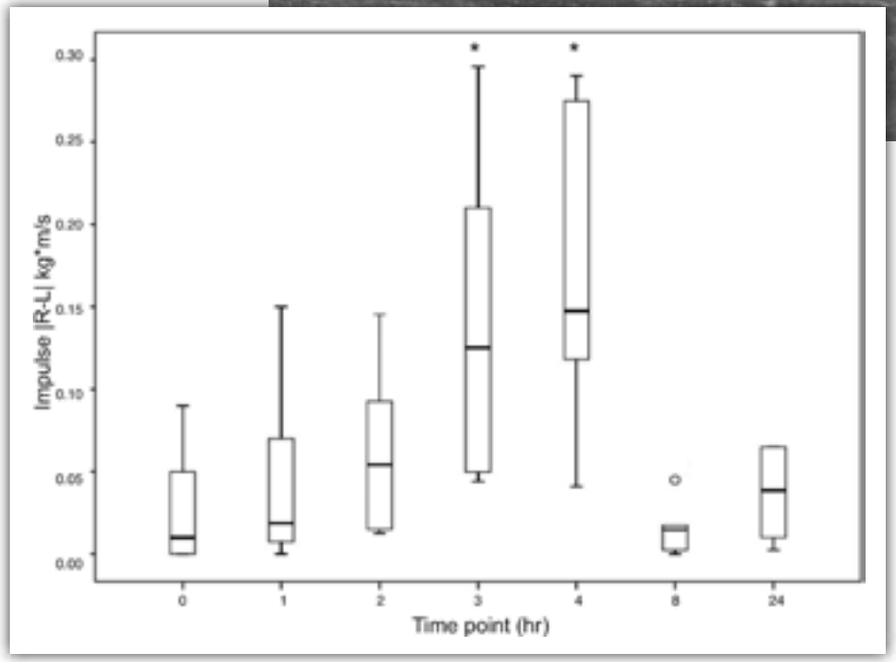


Figure 2

Box plot depicting absolute value of the difference between left and right feet of the ducks administered MSU. The asterisks indicate significant lameness apparent between hours 3 and 4 of the experiment.

Results: The results from **Experiment 1** indicated no significant differences between right and left feet for any gait parameter.

In **Experiment 2**, lameness was particularly present during 3-4 hours post MSU injection. Gait parameters following the MSU injection significantly reduced the maximum force (kg and % body weight) and impulse (kg*m/s and % of body weight m/s) put on the injected limb.

However, as shown in **Figure 2**, at some point between hours 4 and 8, lameness appeared less apparent.

The researchers concluded that the High-Resolution Animal Walkway offered a flexible technique to detect gait abnormalities in avian species, with the potential to assess, monitor, and promote improvements on the welfare of birds with lameness causing diseases.

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Pharmacology Testing

CITATION: Rashid, M. H. et. al. "Pharmacological Validation of Early and Late Phase of Rat Mono-Iodoacetate Model Using the Tekscan System." European Journal of Pain. 2013, 17, 210-222. doi:10.1002/j.1532-2149.2012.00176.x

Background: Mono-iodoacetate (MIA) is a metabolic inhibitor that is commonly used as a therapeutic agent to treat osteoarthritis (OA) in humans. Rats have been used as Mono-iodoacetate (MIA) induced chronic joint pain models, where they were typically measured by weight-bearing (WB) deficit with an incapacitance tester. In this process, the rat is restrained inside a two-channel weighing chamber, with two hind libs placed in each channel. Not only does this cause restrain stress to the animal, but measuring the sole use of their hind limbs lacks a clear visual imprint of the quadrupedal animal.

In this study, researchers used a **Very High Resolution Animal Walkway System** as a method to measure their WB asymmetry, without needing to restrain the animal.

- A total of 264 male Sprague-Dawley rats weighing between 175-to-350 g were induced, and injected intra-articularly into their left hind limb knee joint with different concentrations of MIA.*
- Twenty-four hours post injection, the rats were placed onto the Walkway within a habituation chamber. A recording of 100 live images at 10 Hz of each body part was taken.
    - Effects of a single dose of the drugs were examined four consecutive weeks after the MIA injection.
- The WB of each body part (four limbs and the tail) was quantitatively shown as the percent of total body weight from the average value of the 100 images.

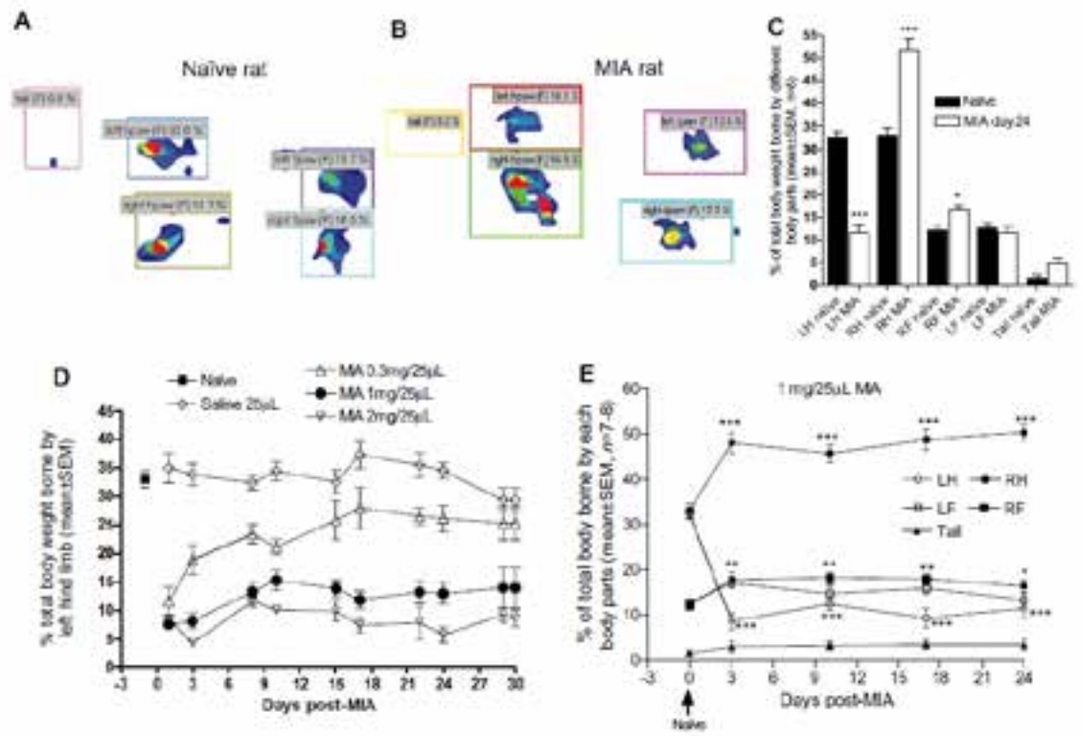

Figure 3

(A): Pressure distribution pattern by four limbs and tail of a naïve rat (n = 1 naïve rat)
(B): Pressure distribution pattern by four limbs and tail of a MIA rat at 24 days after MIA injection. Note the WB decrease on the MIA-injected Left-Hind Paw.
(C): Mean values of WB by each body parts in naïve and day 24 MIA rats (1 mg/25 mL). There was a significant decrease in WB in left hind paw and subsequent significant increase in WB in the right hind paw of MIA rats.
(D): MIA concentration response measured at different time points after injection of 0.3, 1 and 2 mg of MIA in 25 mL of physiological saline.
(E): Weight borne by the four limbs and the tail of rats injected with 1 mg MIA into the left hind knee joint rats at different time points after MIA injection. There were significant changes in WB in left hind (decrease), right hind (increase) and right front (increase) paws at all time points tested, compared with the respective pre-MIA naïve values.

Results: The researchers determined that the left hind knee joint of the MIA-injected rat compensates its WB deficit not only by the contralateral right hind limb, but also by the front limbs. Behavioral pharmacological, electrophysiological, and biochemical studies also confirmed that the late phase of the model is relatively insensitive to NSAIDs. This could be particularly important in order to explore novel drug targets for better relief of OA pain in the clinic.

Based on the results, the researchers concluded that the Walkway system was successful in quantitatively assessing WB asymmetry in the rat MIA model, eliminating several limitations associated with the typical incapacitance system.

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* This study was conducted under a protocol that has been approved by an ethical committee, and adhered to the guidelines of the Committee for Research and Ethical Issues of the International Association for the Study of Pain.

Kinetics & Kinematics

CITATION: Faramarzi, B. et. al. (2018) "Changes in Hoof Kinetics and Kinematics at Walk in Response to Hoof Trimming: Pressure Plate Assessment." Journal of Veterinary Science 2018, 19(4), 557-5.

Background: Routine hoof trimming is vital for equine performance. In daily practice, farriers and trimmers evaluate hoof balance by visual assessment. However, this is an imperfect practice that can significantly affect the well-being of a horse.

Researchers in this study used a **MatScan XL2 System** to assess the effect of hoof trimming on hoof biomechanics of nine clinically sound Arabian horses (five mares and four geldings). They analyzed the following parameters:

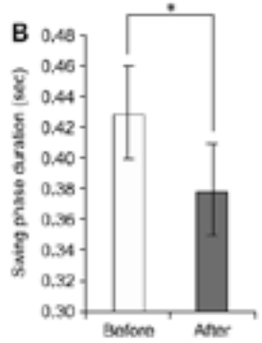
- Vertical force
- Pressure
- Contact area
- Peak pressure
- Stance-phase duration
- Swing-phase duration
- Gait-cycle duration
- Duty factor
- Swing phase

Each horse was led across the walkway by a handler at least five times before and after trimming.

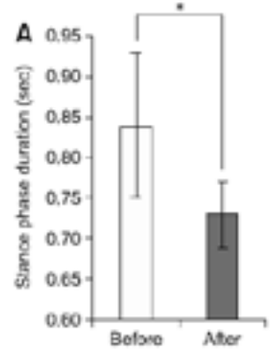
Results: As shown on the right, there were significant changes in kinetic and kinematic parameters following trimming. Vertical force and contact pressure increased, while stance-phase, swing-phase, and gait-cycle duration decreased.

The High-Resolution Animal Walkway was able to capture these significant details that could have been missed by visual observation.

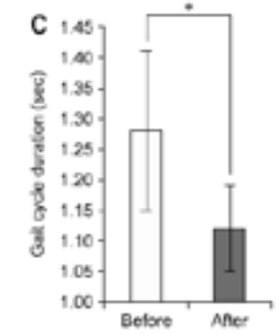
Swing-Phase Duration



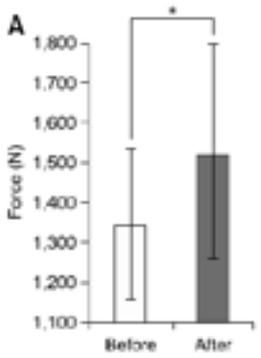
Stance-Phase Duration



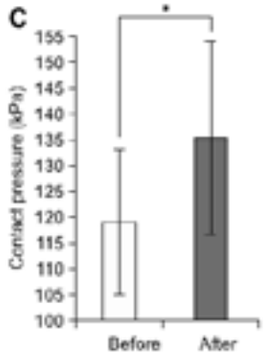
Gait Cycle Duration



Vertical Force



Contact Pressure



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Jumping Assessment

CITATION: Stadig, S., Bergh, A. "Gait and jump analysis in healthy cats using a pressure mat system." Journal of Feline Medicine and Surgery. 19 September 2014.
DOI: 10.1177/1098612X14551588

Background: Like many animals, cats in pain from osteoarthritis may not always show visual signs of discomfort. This can often lead to undiagnosed cases, especially among geriatric cats.

Because pressure-sensitive walkways, like the **High-Resolution Animal Walkway System**, allow veterinarians and researchers to analyze several step cycles, researchers in this study wished to see whether this type of technology could be used reliably as a diagnostic tool.

Along with a gait analysis study, the researchers subjected 28 cats to a jump analysis trial:

- Cats were placed on a 1-meter high examination table, then would jump down onto the walkway after encouragement from the researcher
- A valid jump would only be considered after the cat landed and continued walking straight forward

Results: Sixteen out of the 28 cats produced 55 valid jumps. The results showed that a majority of cats landed with both front paws horizontally, and at the same time, they landed with hind paws symmetrically in relation to the front paws.

While more studies are needed, the researchers suggested that the time between the front and hind paws hitting the walkway could be an additional indicator in the diagnosis of cats with painful orthopedic conditions.

Figure 4
Cats were involved in both a gait analysis and jump test, in an effort to determine whether pressure-sensitive walkways could help in the diagnosis of orthopedic issues.

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Flooring Design

CITATION: Oehme, Be. et al. "Effect of different flooring types on pressure distribution under the bovine claw – an ex vivo study" BMC Veterinary Research (2018) 14:259.

Background: Livestock animals spend much of their lives walking on hard surfaces, particularly concrete and rubber. Over time, their claws can be subject to lesions and other claw diseases.

In this research experiment, a **Hoof System** was used to examine the kinetic influence of four different flooring types (one concrete, and three different types of rubber) on the sole of a bovine claw.

- Twelve hind limbs of adult Holstein Friesian dairy cows from an abattoir were separated below the joint immediately after their slaughter
- The claws were trimmed, and the legs were affixed to a load applicator, which applied a load of 240 kg onto the sensor (resulting in a final load of 143 ± 9 kg under the claws)
    - As shown in **Figure 4**, in order to simulate the in vivo situation as close as possible, the deep digital flexor tendon and the digital extensor tendons were pulled proximally with 500 and 50 N, respectively
- A protective foil was placed over the Hoof System sensor

Figure 5
Experimental setup; A = load applicator, B = clamped tendons, C = securing strap, D = Hoof sensor, E = rubber mat, F = concrete, G = digital scale.

Results: After data collection, the researchers determined that the rubber flooring material produced better mechanical relief on the bovine claw compared to the concrete surface. **Figure 5** shows one particular test, where peak pressures indicated by the yellow and green were far more apparent, while more even pressure distribution was displayed on the other three rubber types (KARERA, KURA, profiKURA).

The researchers also suggested that a similar test could be useful when comparing against future flooring types.

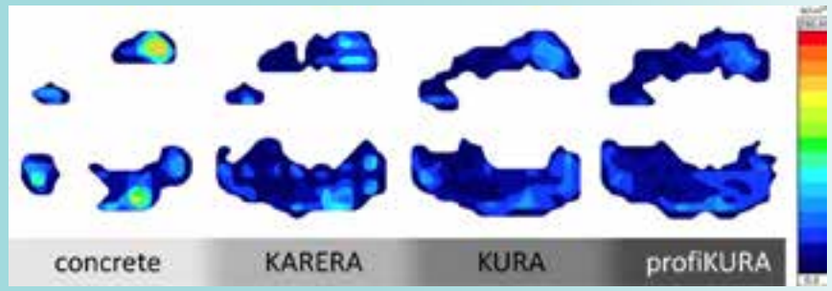

Figure 5
Example pressure imprints of one claw on the different tested floorings.

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CONCLUSION

How Can Your Research Benefit from Actionable Gait Analysis Technology?

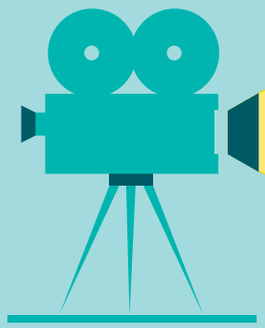
No matter your research goals, Tekscan technologies provide objective data for quantified analysis that deliver results. Unique insights from these systems help researchers and veterinarians identify asymmetries and abnormalities that may otherwise go undetected by visual observation.

For more ways Tekscan technologies have been used in veterinary research and animal science, review our extensive, up-to-date bibliography.

Let's start a conversation.

When it comes to gait analysis, we at Tekscan understand the challenges researchers and veterinarians face. Our representatives are standing by to help you enhance your research and improve the lives of animals across all species.

Visit www.tekscan.com/medical or call 1.617.464.4282 for more information.



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