Electromyographic Analysis of the Hind Limb Muscles of Healthy Labrador Retrievers

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Introduction

Electromyography (EMG) allows for detection and quantification of the muscular activity and is commonly used in human movement studies. In veterinary literature, there is a paucity of work characterizing muscular activation patterns in canine limbs during gait.

The objectives of the study were to quantify the duration of muscle activation, ratio of activated/resting muscle duration and to determine the timing of muscle activation during trotting gait in Labrador Retrievers.

Materials and Methods

- 8 clinically normal Labrador Retrievers (Age: 5.27 ± 3.6 years; Weight 29.8 ± 4.4 kg) were tested.
- Subjects trotted on a force plate-instrumented dual-belt treadmill (Bertec Corp, Columbus, OH) at speed of 2m/s. The force plates were sampled at 100Hz.
- The EMG signal of the quadriceps, hamstring, and gastrocnemius muscle groups were recorded using surface EMG electrodes (Bagnoli®, Delsys, corp, Boston, MA, USA) (Figure 1).
- 5 trials of the right hind limb were analyzed per dog.
- The EMG signal was synchronized with force data, rectified and filtered using MATLAB. A 4th order Butterworth filter was use with a cut-off frequency of 18Hz.
- A gait cycle of the right limb was defined by the ground reaction force (GRF). The first and second peak represent mid-stance phases for the hind and fore limbs, respectively (Figure 2). .
- The followings parameters were investigated :
  - Duration of muscle activation during a gait cycle
  - Ratio of muscle activation time to muscle inactivation time (Ratio – on/off)
  - Ratio of muscle activation time to duration of gait cycle (Ratio – on/time)

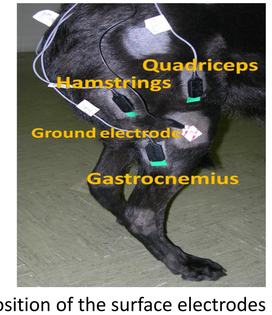

Figure 1: Position of the surface electrodes over the quadriceps, hamstring and gastrocnemius muscle groups of the right hind limb. A ground electrode is also visible.

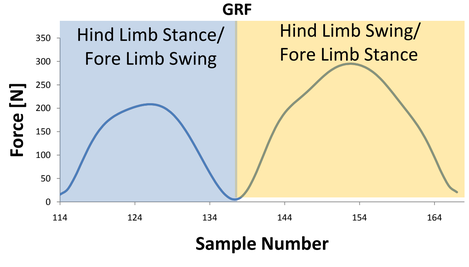

Figure 2: Ground reaction forces (in N) of the right limb during the stance phases of the right hind and fore limbs. The fore limb stance phases corresponds to the hind limb swing phases, and conversely.

Result and Discussion

- The averaged duration of the gait cycle was 0.48 ± 0.04 s.

Similar activation patterns were found for multiple gait cycles across different subjects:

- The quadriceps muscle group was active during most of the stance and the mid-swing phases (Figure 3).
- The hamstring muscle group was active from the end of swing to mid-stance and also during mid-swing (Figure 3).
- The gastrocnemius muscle group was active from end of swing to early stance, mid-stance phase, and the early swing phase (Figure 3).
- The hamstring muscle group was less active than the two other muscle groups (Table 1).

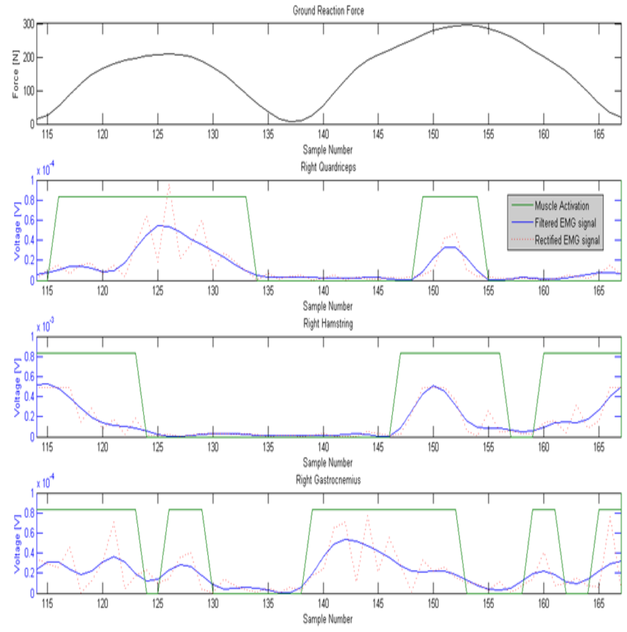

Figure 3: Ground reaction forces and EMG signals of the quadriceps, hamstrings and gastrocnemius muscle groups for a whole gait cycle for one subject. The first peak of GRF represents the stance phase and the second peak represents the swing phase of the right hind limb. The EMG signals (green) documented muscle activation.

Table 1: Summary of average activation ratios of the quadriceps, hamstrings and gastrocnemius muscles of the right hind limb of Labrador Retrievers (n=8).

	Quadriceps	Hamstring	Gastrocnemius
Ratio - On/Time	0.54 ± 0.094	0.46 ± 0.12	0.51 ± 0.13
Ratio - On/Off	1.44 ± 0.58	0.96 ± 0.42	1.24 ± 0.58

Conclusion

The activation pattern of the quadriceps, hamstring, and gastrocnemius muscle groups were characterized in healthy trotting Labrador Retrievers. The hamstring muscle appeared to be the least activated muscle group during treadmill trotting gait, based on the on/off ratio.

These EMG data obtained may be used to establish reference normal EMG patterns in dogs which could be used to detect abnormal muscle activities in future studies.

Acknowledgements

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