Variability of vertical ground reaction forces collected with one or two force plates in healthy dogs

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Introduction

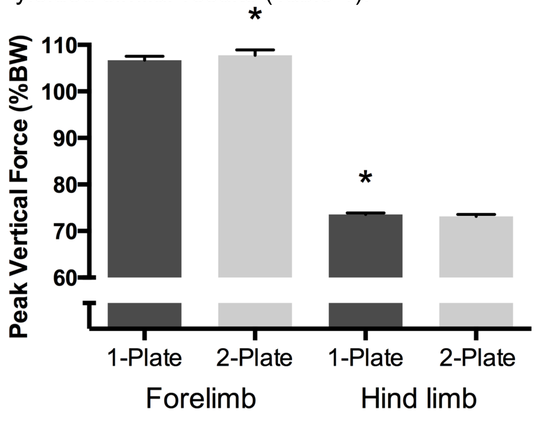
Kinetic canine gait analysis is an important outcome measurement for assessing lameness and dysfunction in patients with musculoskeletal pathology. When collecting GRF data, numerous factors can affect the values obtained and ample data has been produced to show impact of factors such as trial velocity, trial repetition, day-to-day variation, limb (right vs left), conformation and breed.(1-3) The vast majority of this data was collected by a single force platform system. Recently data has suggested that excessive trial repetition may have several negative effects including increasing data variability in both normal and lame dogs. The objective of the study reported here was to compare PVF and VI data collected with one or two force plates during the same collection time period in healthy dogs at a trot.

Materials & Methods

Seventeen healthy client-owned adult dogs (17.8-40.8kg) were used. Gait data was collected from each dog in a crossover study design, with four sessions on two consecutive days, and then two weeks apart (days 1, 2, 15, and 16) using both 1 plate and 2 plate collection methods. The order of the collection method (1-plate or 2-plates) was randomized. Two force plates were mounted in series at the center of a 12-m platform. The GRF data (PVF and VI) was collected and normalized to the individual body weight and expressed as its percentage. Each dog was trotted across the platform by a single handler at a velocity between 1.7 and 21 m/s, and an acceleration of -0.5 and 0.5 m/s. (4) The vertical GRF data was collected for all four limbs with the aid of a dedicated computer and software program. When collecting single force plate data, a valid trial was defined the ipsilateral fore and hind feet striking the force plate. When collecting with two force plates, a valid trial was defined as a forefoot strike on the first force plate, with the ipsilateral hind foot striking the same plate afterward and the contralateral feet striking the second force plate in the same manner. A repeated measures ANOVA was used to test for differences in PVF, VI and average time per trial between days, weeks, and systems (1 plate vs. 2 plate). The full repeated measures model included fixed factors for day (1 or 2), week (1 or 2) and plate (1 or 2) and all two- and three-way interaction terms and a random intercept for each dog. Coefficients of variation for PVF and VI were also calculated separately by fore and hind limbs, plates, day and week. All hypotheses were 2-sided with significance at ($\alpha < 0.05$).

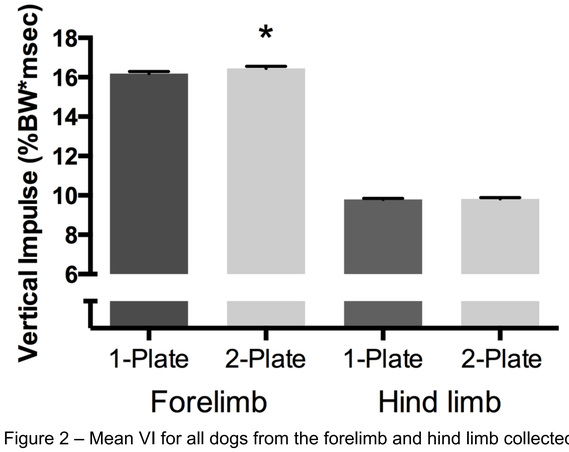
Results

Time required to obtain a valid trial was significantly longer using a single force plate when compared with two force plates ($p < 0.001$). When comparing the ground reaction force data for all dogs, significant differences in PVF data were found between a single and two force plates (Figure 1). Examination of the VI data (Figure 2) found significant differences only in the front limbs between the two collection techniques, with greater values recorded by the two force plates ($p < 0.001$). Evaluation of GRF data obtained with one or two force plates revealed significant inter-day differences only in the PVF data from the front limb. Inter-week GRF data comparison (Days 1+2 vs Days 15+16) found significant difference only in the front limb PVF data when collected with the two force plates ($p<0.001$). Examination of the coefficients of variation for PVF and VI during the different collection periods yielded similar results (Table 1).



(*) indicates a statistically significant difference between the two techniques for the forelimb or hind limb and also indicates the technique with the larger mean value.

Figure 1 – Mean PVF for all dogs from the forelimb and hind limb collected with a 1-plate and 2-plate



(*) indicates a statistically significant difference between the two techniques for the forelimb or hind limb and also indicates the technique with the larger mean value.

Figure 2 – Mean VI for all dogs from the forelimb and hind limb collected with a 1-plate and 2-plate

Results

	1-Plate System				2-Plate System			
	PVF		VI		PVF		VI	
	Forelimb	Hind limb	Forelimb	Hind limb	Forelimb	Hind limb	Forelimb	Hind limb
Inter-Day	3.31	2.64	3.72	2.12	3.14	2.81	3.28	2.28
Inter-Dog	9.38	7.47	10.99	14.07	9.48	8.49	10.53	13.96
Intra-Day	2.61	2.32	2.98	3.12	2.45	2.7	3.53	3.7
Inter-Week	3.17	2.55	3.52	2.44	2.43	3.33	3.66	2.21

Table 1 - The coefficient of variation (CV%) for the forelimbs and hind limbs of all dogs for PVF and VI data when collected with a 1-plate or 2-plate technique

Discussion

There was a significant difference in the time required to obtain a valid trial and the number of trails needed to collect 5 valid trials using a single force plate when compared with two force plates. The results showed a difference in the PVF and VI values, but no consistent difference in the coefficients of variation in PVF and VI values, collected by one or two force plates for the fore and hind limbs in healthy dogs at a trot.

Conclusions

The data presented here confirms that both one and two force plate collection techniques provide consistent repeatable vertical GFR data. Using a two plate system decreases the collection time and number of trial repetition need to obtain such data. The use of a two plate system did not decrease the variation in data collected during each measurement period.

References

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