Accelerometry, a new tool to assess gait quality of dystrophin-deficient dogs

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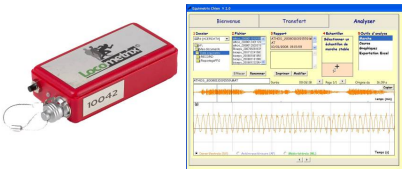
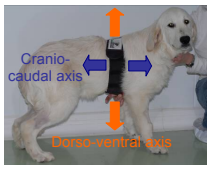
Introduction

Promising therapeutic strategies for DMD are now rising to the challenge of systemic administration in dystrophin-deficient dogs, the most pertinent pre-clinical model of this disease. In this context, the development of functional evaluation tools, including gait evaluation methods, is required. The aim of this study was to determine wether accelerometry, a 3D-recording of accelerations technic, was able to answer the following demands : 1) to be non-invasive and well-tolerated by the dogs 2) to be simple to perform 3) to offer quantified, repeatable and discriminating parameters.

Material and method

The accelerometer, manufactured by Centaure Metrix, is positioned near to the gravity centre (xiphoid process of the sternum) using a belt tightened around the thorax.The dog is encouraged to walk as spontaneously as possible along a 30m corridor. A 5m timing zone is delimited at the end of the first third of the course, in order to obtain the value of speed. The recording 3-axial data are then transferred to the software Equimetrix ®. Samplings of 10 seconds of steady state locomotion are selected and analysed using the algorithms of the software, which offers many quantified data. Dystrophin-deficient dogs are from Golden (GRMD) or Labrador Retrievers (LRMD) colonies.





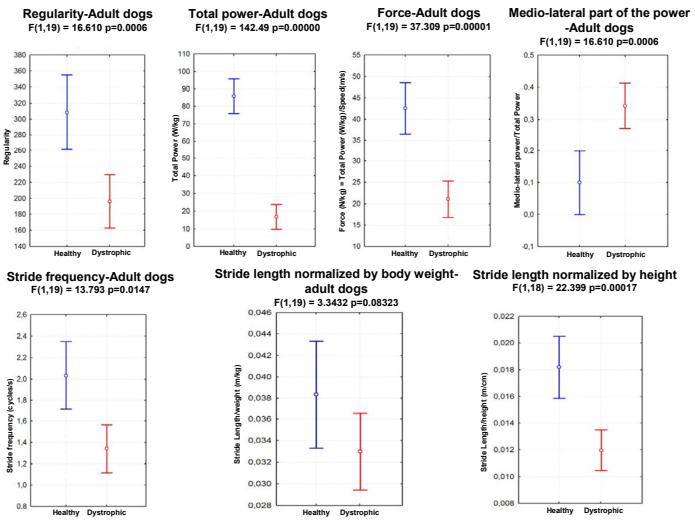
I. Repeatability study

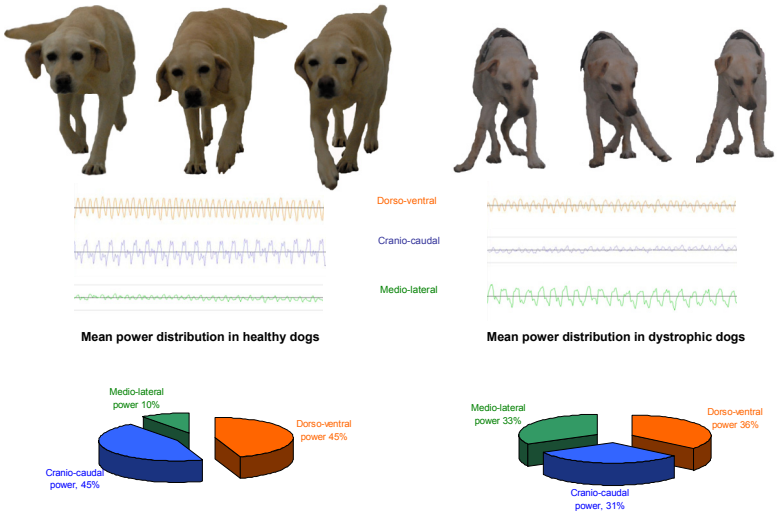
Three repeated recordings were performed in 5 healthy and 12 GRMD dogs. For each recording, 2 samples were analysed. 6 different parameters of interest were tested using a repeated measures ANOVA. No significant difference is observed between and within recordings in healthy and dystrophic dogs, except for regularity in dystrophic dogs (between effect).

		Regularity		Total Power (W/kg)		Medio-lateral/Total Power		Stride frequency (/s)		Stride length (m)		Force (N/kg)	
		within	between	within	between	within	between	within	between	within	between	within	between
Healthy	p	0.390	0.517	0.997	0.971	0.943	0.702	0.426	0.115	0.486	0.704	0.443	0.639
	F	0.926	0.717	0.000	0.029	0.006	0.369	0.785	2.864	0.588	0.366	0.722	0.473
Dystrophic	p	0.919	**0.037** *	0.061	0.127	0.498	0.908	0.691	0.334	0.262	0.473	0.917	0.460
	F	0.011	3.851	4.355	2.267	0.492	0.097	0.167	1.152	1.410	0.778	0.012	0.856

II. Gait analysis study in adult dogs

Seven healthy and 14 dystrophin-deficient adult dogs, with various forms of the disease (locomotor clinical score ranging from 6 to 19/22), were examined in order to determine if the chosen parameters were able to discriminate the 2 groups. For each dog, the mean value of each parameter was used for an analysis of variance. The 6 parameters are found to be significantly different between the 2 groups. The most discriminant parameter is the total power, even divided by speed, avoiding bias due to different types of gait. An interesting point is the increased medio-lateral part of the power in dystrophic dogs : this makes objective and quantitative the obvious swaying component of their gait. In order to avoid variations of stride length due to different sizes of dogs, this last parameter was either normalized by body weight, or by height. Only height, which better reflects the size of these underweight dogs, led to a significant difference, suggesting also that weight should not be the chosen size indicator for this model.

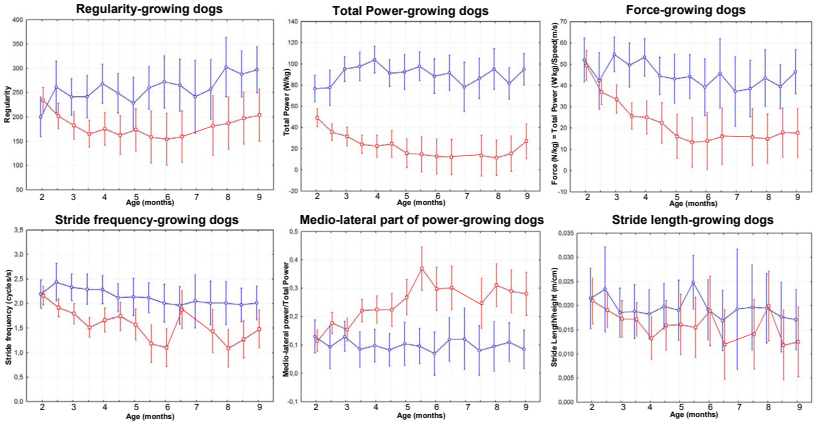




III. Gait analysis study in growing dogs

Eleven healthy and 18 dystrophic growing dogs have been included in a longitudinal study, from 2 to 9 months of age, in order to describe the evolution of the 6 parameters validated in adults. These parameters do not differenciate the 2 groups at 2 months, but become discriminating with age, except the total power which is already decreased in young dystrophic dogs. Conversely, the stride length, even normalized by height, does not clearly distinguish both evolutions.

Age (months)	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Nbr of healthy dogs	7	4	8	6	7	7	4	6	4	4	2	3	3	5	5
Nbr of dystrophic dogs	16	17	14	15	10	7	6	4	4	4	0	3	4	4	4



Conclusion

Accelerometry, the first quantitative method of gait analysis developed in dystrophin-deficient dogs, represents a precious tool for the functional evaluation of these pre-clinical patients, since it answers to several critical demands : simple, non-invasive method, well tolerated, transposable to humans, source of at least 6 objective, quantitative, and discriminating parameters.

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