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Comparison of range of motion in Labrador Retrievers and Border Collies

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The objective of this paper was to compare the range of motion in Border Collies to that of Labrador Retrievers. Humeral circumference, thigh circumference and differences between sex and age were also compared. Twenty three (23) healthy Border Collies and 18 healthy Labrador Retrievers were used. A single investigator measured range of motion of the carpus, elbow, shoulder, hip, stifle and tarsus as well as humeral and thigh circumference under field conditions in 23 Border Collies and 18 Labrador Retrievers. Border Collies had a significantly greater range of motion (P<O.001) in all joints than Labrador Retrievers. Sex was a significant predictor of range of motion (P=0.010), but age was not (P=0.400). Range of motion significantly varied by joint (P<0.001) and the effect was different within Border Collies versus Labrador Retrievers (P=0.008). Range of motion did not vary between left and right sides (P=0.365). Considerations of range of motion were made in deciding pathology and progress based on type and breed of dog (sporting, herding, protection). Comparisons were made based on breed and from left side to right side.

Key words: Range of motion, goniometry, flexion, extension, and abduction.

INTRODUCTION

Range of motion (ROM) is the distance and direction that a joint can move between positions to its full potential such as flexion and extension. Goniometry is the measurement of angles, and this is how range of motion is evaluated in human physical therapy and animal rehabilitation (Boone and Azen, 1978; Riegger-Krugh and Millis, 2000). Limits in range of motion help quantify deficiencies and aid in documenting improvement after surgery and during animal rehabilitation (Mölsä, 2014). Normal range of motion measurements have been established via goniometry on Labrador Retrievers (Jaegger, 2002).

Seventy percent thigh circumference with the leg in extension is an indirect method of assessing changes in muscle mass in the hind limbs of canines and animal physiotherapists when evaluating orthopedic disease (Millis and Scroggs, 1999; Molsa, 2014). Antebrachial (humeral) circumference (just above the elbow around the humerus and associated musculature) is the most common indirect measurement of general front leg musculature used at some rehabilitation practices.

However, if a breed or type of breed difference exists

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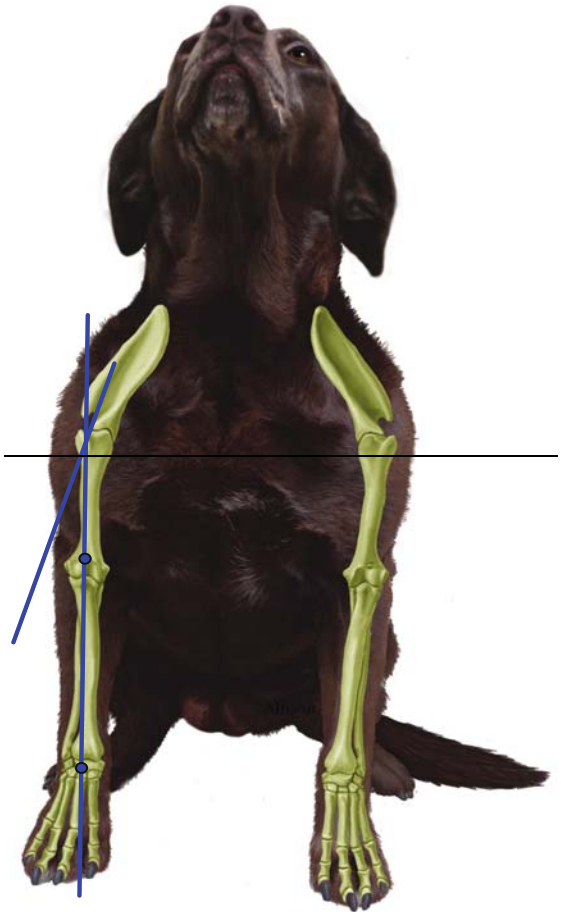

Figure 1. Axis for measuring shoulder abduction with the dog in the sitting position.

for normal values, it would be useful so that a dog is not considered abnormal when the dog has range of motion values within normal limits for that breed or type of breed.

MATERIALS AND METHODS

Dogs

Twenty three Border Collies between the ages of 0.8 and 7 years old (11 males, and 12 females) and 18 Labrador Retrievers between 6 months and 10 years of age (5 males, 13 females) were active on the day of measurement, but no dog had passive range of motion performed on them before study measurements were taken. The dogs included in this study did not have clinical sign of lameness, palpable pain or muscle tightness or laxity or a history of trauma or surgery on the legs on the day of or prior to the measurements. Radiographs and CT scans were not performed on animals included in this study, as the measurements were taken in field conditions. Sex (intact or neutered) was not a factor in selection of cases. All dogs had the same measurements taken at the same time and in the same order of location (hip flexion and extension, stifle flexion and extension, tarsal flexion and extension, 70% thigh circumference, shoulder flexion and extension, elbow flexion and extension, carpal flexion and extension and shoulder abduction).

Goniometry

The arms of a transparent plastic goniometer[1] were aligned with anatomic landmarks on the limbs (axis) and 1 degree gradations were used for measurements. All joints were measured in lateral recumbency except for shoulder abduction. Flexion and extension for the involved joints were measured per previously described methods (Millis et al., 1999) using the shafts of the bones above and below the joint as guide points for the arms of the goniometer as shown in Figure 2. Shoulder abduction was measured with the dog in a sitting position and the goniometer placed vertically along the cranial aspect of the humerus. The scapula was secured with one hand as the leg was abducted away from the center of the body starting from the zero point axis of the humeral shaft as shown in Figure 1. Care was taken to keep the shoulder and the elbow in extension.

Thigh and humeral circumference

A Gulick II tape measure [2] was applied around the femur at approximately the 70% mark while the dog was in a standing position with the leg extended (Millis and Scroggs, 1999). A Gulick

[1]Cm goniometer, MSD products, Landerzeel, Belgium
[2] Gulick II Measuring Tape, Country Technology, Inc, Gays Mills, Wisconsin

Figure 2. Axis for angles of range of motion measurement of major joints.

II tape measure was applied 1 inch above the elbow for humeral circumference while the dog was in a standing position with the leg extended. Results were obtained to the closest half-centimeter.

Statistical analysis

Data were evaluated for normality by calculating descriptive statistics, plotting histograms, and performing the Anderson-Darling test for normality. The data did not appear normally distributed and therefore was described as median and interquartile ranges (IQR) and rank-transformed prior to statistical analysis. The effect of breed on joint measurements was estimated using repeated measures ANOVA in four independent analyses. The first analyzed measurements were from the elbow, shoulder, carpus, stifle, hip and tarsus in flexion and extension for both right and left limbs. The other analysis evaluated shoulder abduction, humeral circumference (just above the elbow), and 70% thigh circumference using similar ANOVA (Analysis of Variance) models. Analysis included breed as a subject effect while joint, extension versus flexion and right versus left limbs were included as within subject effects. Age (continuous) and sex (categorical) were included in all models as between subject effects to adjust for potential confounding in the evaluation of breed differences. Statistical analyses were performed in commercial software and results were interpreted at the 5% level of significance[3].

RESULTS

Border Collies had a significantly greater range of motion in all joints (P<0.001) compared to Labrador Retrievers (Table 1). Sex was a significant predictor of ROM (P<0.001) with intact females (P=0.013) and spayed females (P=0.034) having a significantly greater ROM than neutered males (Table 2).

Age was not a significant predictor of ROM (P=0.400) based on the ANOVA models. Range of motion significantly varied by joint (P<0.001), and the effect was different within Border Collies versus Labrador Retrievers (P=0.008). Range of motion did not vary by side (P=0.365). Border Collies had significantly greater shoulder abduction than Labrador Retrievers (P<0.001), but did not vary by sex (P=0.903) or age (P=0.653) (Molsa et al., 2014. The mean shoulder abduction angle for Border Collies in this study was 69° with a range of 65 to 73° on both sides. The Labrador Retrievers in this study had a mean of 42.5° and a range of 40 to 44°. Humeral circumference in the Border Collies had an interquartile range of 14.2 to 15.4 cm on both the left and right sides. Humeral circumference in Labrador Retrievers had an interquartile range of 19 to 20 cm on both the left and right sides. 70% thigh circumference in the Border Collies had an interquartile range of 25.6 to 29.4 cm on the left and 25.7 to 28.5 cm on the right side. 70% thigh circumference in Labrador Retrievers had an interquartile range of 34 to 36.6 cm on the left and an interquartile range of 33.3 to 35.3 cm on the right side.

DISCUSSION

Border Collies may have an overall greater range of motion in their joints due to their body conformation and

[3] IBM, SPSS Statistics Version 21, International Business Machines Corp., Armonk, New York USA

Table 1. Range of motion comparison based on breed.

Location	Measurement	Collies	Labradors	P Value*
		Median (IQR)	Median (IQR)	
Elbow	Extension	180 (179, 185)	170 (170, 175)	-
	Flexion	50 (50, 60)	45 (41, 50)	-
Shoulder	Extension	175 (165, 185)	170 (165, 174)	-
	Flexion	50 (40, 50)	40 (40, 45)	-
Carpus	Extension	205 (200, 210)	200 (190, 205)	-
	Flexion	50 (50, 60)	43 (40, 50)	-
Stifle	Extension	180 (176, 190)	169 (165, 172)	-
	Flexion	50 (50, 60)	45 (40, 50)	-
Hip	Extension	170 (155, 175)	159 (151, 160)	-
	Flexion	50 (44, 50)	45 (40, 50)	-
Tarsus	Extension	180 (180, 180)	175 (175, 180)	-
	Flexion	50 (40, 60)	40 (40, 40)	-
Overall	Extension	180 (170, 190)	170 (165, 180)	-
	Flexion	50 (50, 60)	40 (40, 50)	-
Shoulder	Abduction	70 (60, 75)	45 (41, 50)	<0.001
Humerus	Circumference	15 (14, 15)	20 (19, 21)	<0.001
Thigh	Circumference	27 (25, 30)	35 (33, 37)	<0.001

IQR: Interquartile range; *Repeated measures ANOVA comparing Collies and Labradors while adjusting for sex and age.

activities (herding) that they are selectively bred for over time. According to the AKC breed standard, the Border Collie's elbows are neither in nor out. Stifles are well turned with strong hocks that may either be parallel or very slightly turned in. The Border Collie's most used working gaits are the gallop and a moving crouch (stealth) which converts to a balanced free trot, with minimum lift of feet. The trot covers the ground with minimum effort, exhibiting facility of movement rather than hard driving action. Viewed from the rear, the hindquarters drive with thrust and flexibility with hocks turning neither in nor out, moving close together, but never touching (The American Kennel Club, 2006). On the other hand, the AKC breed standard for Labrador Retrievers states that the elbows should be held neatly to the body with the legs not too close together. The hind legs are strongly bonded, muscled with moderate angulation at the stifle, and powerful, clearly defined thighs. The angulation of both the stifle and the hock joint is such as to achieve the optimal balance of drive and traction (The American Kennel Club, 2006).

Females have greater range of motion than males. These findings are consistent with results of humans (Berryman-Reese and Bandy, 2010). Increased testosterone in men allow for increased muscle mass, and increased muscling or fat surrounding joints makes for less range of motion of that joint (Berryman-Reese and Bandy, 2010; Hall, 2012).

Age was not associated with a decreased range of motion in the studied dogs. However, it has been noted in humans, that with the exception of hip extension, at least to the age 74 years, any substantial loss of joint mobility should be viewed as abnormal and not attributable to aging (Roach and Miles, 1991).

A previous study in dogs with medial shoulder instability repeated more excessive angles of abduction with a mean of 53° versus that in unaffected shoulders with a mean of 32° (Cook and Renfro, 2005). However, no Border Collies were included in the study. The mean shoulder abduction angle for Border Collies in this study was 69° with a range of 65 to 73° on both sides. The Labrador Retrievers in this study had a mean of 42.5° and a range of 40 to 44° which had previously been within the normal shoulder abduction measurement for dogs (Millis et al., 2003). Another study found that abduction, adduction and rotation around the longitudinal

Table 2. Range of motion comparison based on sex.

Location	Measurement	Intact female	Spayed female	Intact male	Neutered male
		Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Elbow	Extension	174 (170, 179)	180 (174, 186)	180 (170, 181)	180 (169, 185)
	Flexion	50 (45, 50)	50 (49, 60)	50 (49, 51)	50 (49, 51)
Shoulder	Extension	170 (165, 175)	175 (170, 185)	168 (160, 175)	165 (160, 171)
	Flexion	43 (40, 50)	45 (40, 50)	45 (40, 50)	40 (40, 50)
Carpus	Extension	205 (200, 210)	200 (195, 210)	200 (194, 210)	205 (200, 210)
	Flexion	50 (40, 50)	50 (49, 60)	50 (50, 56)	50 (40, 60)
Stifle	Extension	174 (165, 180)	180 (170, 190)	175 (165, 180)	178 (160, 181)
	Flexion	50 (41, 50)	50 (45, 53)	50 (40, 56)	50 (40, 60)
Hip	Extension	160 (155, 170)	160 (154, 180)	160 (155, 170)	155 (148, 166)
	Flexion	45 (40, 50)	50 (45, 50)	50 (44, 50)	48 (40, 51)
Tarsus	Extension	180 (175, 180)	180 (174, 180)	180 (175, 180)	180 (175, 180)
	Flexion	40 (40, 40)	50 (40, 60)	40 (40, 50)	45 (40, 60)
Overall	Extension	175 (170, 180)	180 (170, 190)	175 (170, 180)	175 (161, 180)
	Flexion	45 (40, 50)	50 (45, 54)	50 (40, 50)	50 (40, 50)

IQR: Interquartile range; *Repeated measures ANOVA comparing Collies and Labradors while adjusting for sex and age.

axis of the upper arm differ up to 40 degrees between breeds (Fischer, 2010).

Although body weights or body condition scores were not recorded for each of the dogs in the study, the 70% thigh and humeral circumferences for each breed had a narrow range. Measurement of thigh circumference is an indirect method of assessing changes in muscle mass (Millis and Scroggs, 1999). Humeral circumference in the Border Collies had an interquartile range of 14.2 to 15.4 cm on both the left and right sides. Humeral circumference in Labrador Retrievers had an interquartile range of 19 to 20 cm on both the left and right sides. 70% thigh circumference in the Border Collies had a range of 25.6 to 29.4 cm on the left and 25.7 to 28.5 cm on the right side. 70% thigh circumference in Labrador Retrievers was 34 to 36.6 cm on the left and 33.3 to 35.3 cm on the right side. This would indicate a very close cohort of individuals as regard to muscle mass and frame size in both breeds.

Some limitations of this study include the absence of a power analysis. However, numbers of dogs used were similar to a previous study and measurements on both sides of the body were performed (Cook et al., 2005). A second limitation may be that the measurements were performed by a single investigator. The reliability between investigators has been established in both animals and humans (Cook et al., 2005; Roach and Miles, 1991). However, having a single investigator in this study may actually be considered a strength, as there is virtually no variability in technique.

Further studies are needed to establish normal range of motion values for breeds or types of dogs (working, herding, sporting, toy). Although changes in range of motion are not specific for a disease entity, they are reliable for progression of a disease or recovery. Changes in range of motion should be used in conjunction with degree of lameness, pain, comparison of the contralateral limb, breed, sex and diagnostic modalities such as radiographs, diagnostic ultrasound, and MRI exams.

Conflict of interest

The authors declare that they have no conflict of interest.

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