Goniometric Measurements of the Angular Values of the Joints in the Fore- and Hindlimbs of Kangal Dogs*

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ABSTRACT

This study determined angular values of the joints of Kangal dogs for the fore- and hindlimbs using the technique of goniometry for comparison between the sexes. Fourteen female and 14 male dogs were used to document the angular range of motion (ROM) of the joints, and 10 female and 8 male dogs were used to measure zero positions. The mean angular values of zero position in the female dogs were 59.2º ± 4.16º, 32º ± 2.66º, 20.3º ± 1.06º, 69.8º ± 5.20º, 42.6º ± 2.56º, and 26.1º ± 3.05º in the shoulder, elbow, carpal, hip, stiffle, and tarsal joints, respectively. Likewise, the data in the male dogs were 45.87º ± 4.22º, 34.12º ± 3.28º, 18º ± 0.92º, 62.12º ± 3.37º, 39.12º ± 3.76º, and 26.75º ± 2.7º, respectively. There were no statistical differences between the sexes for the angular values at zero position of all the joints except the shoulder. Similarly, the mean ROM values were 105.69º ± 3.83º, 123.28º ± 2.63º, 141.28º ± 3.95º, 103.28º ± 3.69º, 118.57º ± 3.26º, and 108.21º ± 6.18º in the female, and were 106.07º ± 4.80º, 121.27º ± 2.35º, 133º ± 3.76º, 98.1º ± 2.47º, 118.23º ± 3.29º, and 110.92º ± 4.77º respectively in the male dogs. As far as the gender was concerned, the mean ROM values between the sexes were found to be statistically insignificant. The findings have revealed that the angular values of the joints at natural anatomical posture and their passive ranges of motion are lower than those of the dog breeds examined by the literature, suggesting that Kangal dog does not seem to be in the range for the race dog category.

Key words: Goniometer, Joints, Kangal dogs, ROM, sex differences

INTRODUCTION

The Kangal dog is a famous shepherd breed of Turkey, which has been naturally selected for the climatic conditions of in Anatolia and the Near East. This breed has also become very popular worldwide, particularly in the USA, where "The Kangal Dog Club of America" was founded in 1984 (1). The breed is thought to have originated from North Eurasia, reaching Anatolia with human migration (2). It is highly preferable among the shepherds in Anatolia for its acute vision and smell, courage, power, endurance against very harsh climatic conditions, and devotion to its owner (3).

Description of the passive joint range of motion (ROM) is an essential parameter particularly for the verification of outcomes after surgical procedures in clinics (4) and is performed by the use of different types of goniometers (5-11). Moreover, determining ROM ability of the joint in question and its functional capacity in canine populations contributes profoundly to the evaluation of the development in various pathological conditions and rehabilitation processes, leading to the assessment and response to treatment following injury and surgery (4,12). It is also performed in the case of loss of joint motion ability and evaluation of the ROM (10-13).

In goniometric measurements, zero (*in situ* anatomical, neutral) position, stabilization of the joint, proper emplacement for goniometry, and choice of the most suitable type of goniometer are the most important factors affecting the measurement (10,11,13). Universal Goniometry is commonly preferred because of its practical usage. A goniometer for the measurement of the range of motion of an animal joint has an anchor platform to which the upper leg can be attached, and a mobile platform to which the lower leg can be affixed so that the upper and lower legs are situated along a common axis. The mobile platform is preferably movable in two degrees of freedom. A force transducer and a torque transducer may be applied to acquire the measurements of the laxity of the joint (4, 6).

The ROM values have been reported in various dog breeds including Labrador retrievers (4,14). However, published measurements of ROM in dogs have been inconsistent in description, complicating the evaluation of the results. To date, no report has been published on the ROM of the joints in the Kangal dog. This study therefore documented the goniometric measurements of the ROM in the fore- and hindlimbs of the Kangal shepherd dog. The measurements particularly focused on the zero position and ROM, total flexion-extension capacity at passive status of the shoulder, elbow and carpal joints in the forelimb, and of the hip, stifle, and tarsal joints in the hindlimb. The data displayed is proposed to serve as a database, thus contributing to the related clinical research activities

MATERIAL AND METHODS

A total of 100 dogs were examined for inclusion in the study in the Research Center of Kangal Dogs, Cumhuriyet University, Sivas, Turkey, and Ulas/Sivas Kangal Dog Farm, Ministry of Agriculture, Turkey. Twenty eight dogs (14 females and 14 males) were included in the study in order to accomplish statistical comparisons between the gender groups. The criteria for inclusion of animals in the study were that the dogs were registered by the research center and farm indicated above, were 3.09±1.5 year of age, had no orthopedic disease or trauma, had normal results of orthopedic examinations, and had no radiographic evidence of joint disease and that the females dogs were not pregnant. Zero position measurement, a description of reference landmark and reliability, was determined to describe *in situ* anatomical, neutral, positions of the joints in 10 female and 8 male animals. The zero position of each extremity joint was calculated using the angle between the longitudinal axes of the long bones constituting the joint in question, at *in situ* anatomical position (Figure 1). For example, the zero position of the shoulder joint was measured by the use of the longitudinal axes of the spina scapula and humerus.

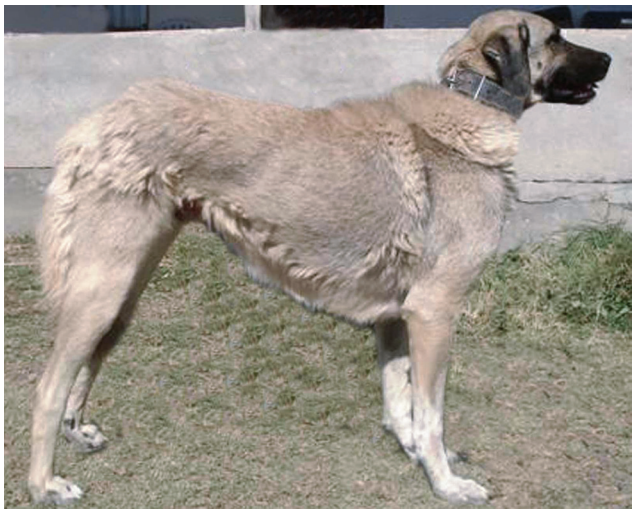

FIG. 1. Natural posture of the Kangal dog

Goniometry

Two types of universal goniometer were used in the study. The large transparent plastic and stainless metal goniometers with one degree increments were used in the measurement of proximally located large scale joints like the elbow joint as displayed in Figure 2 (Sammons Preston Rolyan goniometers, 0-180º, Preston, Australia). Likewise, the small goniometer was applied in the measurement of distally located joints like the carpal joint as shown in Figure 3 (BH T 5613, Phiser, London, England).

Measurements

The measurements were performed by an expert investigator, and were repeated three times calculating the mean value for each parameter. One forelimb and ipsilateral hindlimb of the right side were evaluated on each dog, and alternated for each subsequent animal. Before the measurement, each joint was moved through an entire range of motion to evaluate the axis of joint rotation and only then was the center of goniometer was sited over that axis. The angular values of the joints at natural anatomical posture were measured as the zero position measurement, which revealed the particular anatomical

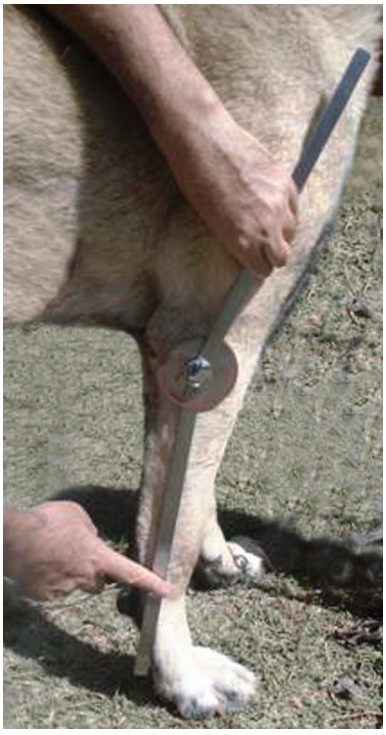

FIG. 2. Large goniometer applied on the elbow joint

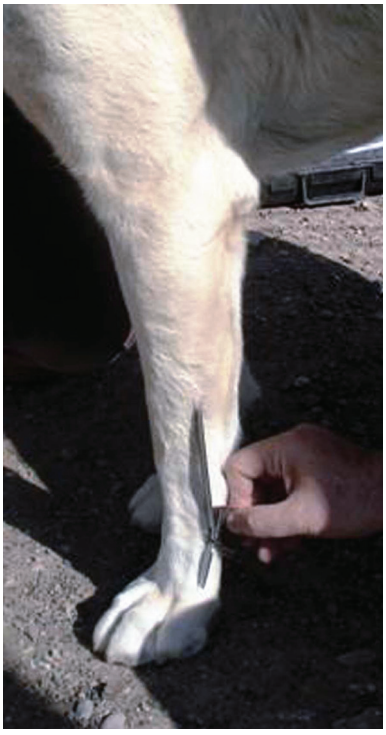

FIG. 3. Small goniometer applied on the carpal joint.

position of the Kangal dogs, as displayed in Figure 3. All the measurements of range of motion were made with the dog conscious and lying in lateral recumbency, without any sedation. The measurements were recorded using the anatomical landmarks indicated by methods in the literature (4,14).

Data analysis-results of measurements were statistically analyzed comparing male and female dogs, using the student's t-test by the application of SPSS 15.0 software. For all comparisons, differences were considered significant at values of $p<0.05$.

Nomina Anatomica Veterinaria 2005 was used for the anatomical nomenclature (15).

RESULTS

The study on goniometric measurements of the ROM of the joints was performed on 14 female and 14 male dogs after veterinary examination. The number, age, and gender of the animals used in the study are presented in the Table 1.

Ten female and eight male dogs from the group which were used to determine the ROM values were also included in the study to measure the zero position of the joints in the fore- and hindlimbs. It was not possible to determine the ROM of the joints on measuring the zero position on all dogs, due to certain difficulties in behavior of the dogs. The results were statistically analyzed with regard to gender and are presented in Table 2.

The statistical analyses revealed no significant differences between the measurements based on the gender in all the joints with the exception of the shoulder joint ($p<0.05$).

The results on the ROM of the joints studied on 14 female and 14 male dogs were statistically analyzed with regard to gender and are presented in Table 3.

Table 1. Characteristics of the Kangal dogs used to determine the ROM of the joints in the fore- and hindlimbs. Of the groups, ten female and eight male dogs were included to measure the zero position of the joints.

Mean age (year)	3.09 ± 1.5
Mean weight (kg)	43.5 ± 6.77
Number of dogs by sex	14 (female) 14 (male)
Total number of dogs:	28

Table 2. Mean values for the zero position (degrees) of the right side joints in the fore- and hindlimbs, regarding the gender.

Extremity	Forelimb			Hindlimb		
Gender	Shoulder joint	Elbow joint	Carpal joint	Hip joint	Stifle joint	Tarsal joint
Male (n=8)	45.87° ± 4.22°	34.12° ± 3.28°	18° ± 0.92°	62.12° ± 3.37°	39.12° ± 3.76°	26.75° ± 2.74°
Female (n=10)	59.2° ± 4.16°	32° ± 2.66°	20.3° ± 1.06°	69.8° ± 5.20°	42.6° ± 2.56°	26.1° ± 3.05°
P value	0.04	0.61	0.13	0.26	0.44	0.87

Table 3. Mean values for the ROM of the right side joints in the fore- and hindlimbs, in terms of gender.

Extremity	Forelimb			Hindlimb		
Gender	Shoulder joint	Elbow joint	Carpal joint	Hip joint	Stifle joint	Tarsal joint
Male (n=14)	106.07° ± 4.80°	121.27° ± 2.35°	133.81° ± 3.76°	98.15° ± 2.47°	118.23° ± 3.29°	110.92° ± 4.77°
Female (n=14)	105.69° ± 3.83°	123.28° ± 2.63°	141.28° ± 3.95°	103.28° ± 3.69°	118.57° ± 3.26°	108.21° ± 6.18°
P value	0.95	0.57	0.18	0.26	0.94	0.73

As far as the results of the ROM of the joints were concerned, the statistical analyses revealed no significant gender differences between the measurements of the right side joints in the fore- and hindlimbs

DISCUSSION

The goniometer is a cheap, reliable and commonly acceptable instrument for determination of the functional capacity of the joints in human and animals (9,10,14). ROM measurements can be performed to measure the active or passive status of the joint (9,14). Measuring the ROM at passive status has been suggested to be more reliable in animals, as has been indicated in human (9). Therefore, this study obtained the ROM measurements performed at passive status of the joints of the fore- and hindlimb in Kangal dogs. In order to limit the variability between testers, only one professionally experienced investigator made the measurements in this study (4,13,14). As no differences have been found between dogs lying on their side or being sedated during measurements, this study was carried out measuring dogs in right recumbence and in a conscious state (4,13,14).

Gender differences have been documented in goniometric studies in different breeds of dogs including the Greyhound (4). Nicholson *et al*. showed that gender, along with the race training and stifle range of motion, affected hip range of motion in Greyhounds (4). The only significant difference between the sexes measured in our study was observed on the measurement of the zero position of the shoulder joint, which was significantly higher in female than in male dogs. Other than that, there were no significant gender differences between the values as far as the zero position and ROM were concerned and therefore we are unable to speculate on the significance of a difference in a single parameter. Individual variations seem to be one of the determining factors on the results acquired in this study.

Even though there are other techniques in determining the ROM measurements including radiology (4) and walk analysis (5,6,12) we have used goniometry on measuring the ROM of the joints since it possesses considerable advantages as compared to those techniques indicated above such as lower cost, simplicity, rapidity, and no requirement for sedation or exposure to radiation. Furthermore other researchers have documented that there is no statistically significant difference between the results of goniometry and those other techniques (4).

This study focused particularly on two groups of parameters: one, the angular values of the joints at natural anatomical posture including the zero position measurement, and the second on the passive ranges of motion of the joints. The former indicates *in situ* localization and particular anatomical positions of the joints, as displayed in Figure 3 while the latter measures the total flexion-extension capacity of the joints at passive status by moving the joints through an entire range of motion. The findings of both parameters in this study were found to be lower than those of other dog breeds examined by the literature (4,13,14).

Researchers have measured the ROM values in the shoulder, elbow, and carpal joints of the Labrador bitch walking on a fitness band, using electrogoniometer, as 24.3°, 51.6°, and 96.5°, respectively (7). Likewise, they have found the results to

be 25.7º, 65.5º, and 136.1º, respectively, in the running position on the fitness band (5). Their results have revealed that, during both the walking and running positions, the elbow and carpal joints are more mobile than proximally located joints. Meanwhile, the ROM values of the shoulder, elbow, and carpal joints in the female Kangal dogs have been measured as 105.69º±3.83º, 123.28º±2.63º, and 141.28º±3.95º, respectively, as presented in Table 3. It is clear that dogs, as is the case in human being, use the total joint motion capacity partially while walking and running. In our study, we have measured the total passive ROM (total flexion-extension capacity) capacity in Kangal dogs therefore explaining why our results tend to be greater than other reported studies.

Researchers have compared the ROM measurements of extremity joints between German shepherd dogs and Labrador retrievers (9). Their results have revealed the fact that all the values of the joints except for the carpal joint are lower in German shepherd dogs than in Labradors even though the data of both studies were greater than our results. Likewise, another study has found the ROM of the shoulder, elbow, and carpal joints to be 118, 143, and 134, respectively, in mix-breed dogs (16). It can be concluded from the passive ROM results of these previous studies that, due to lower ROM values, the Kangal dog has a less mobile joint activity, as compared to Labrador retrievers, German shepherd dogs, and mix-breed dogs (9,13,16). This suggests that this may be due to the greater stability and strength of the Kangal breed as a result of its large muscle masses.

Scientists have reported angular values of the zero position in the hip, stifle and tarsal joints of mix-breed dogs, being 78, 38, and 40, respectively (16). As can be drawn from the Table 2, these values seem to be significantly higher than those found in this study in Kangal dogs, with the exception for the stifle joint. Moreover, the ROM values of the hip, stifle, and tarsal joints in this species have been found to be lower than those in the German shepherd dogs, Labrador retrievers and certain mix-breed dogs (9,13,16). It is well known that apposition of the thigh on the abdomen and joint capsule, and length of the gluteal semimembranous and semitendinous muscles affect the increased hip flexion, which is essential in race-trained dogs. The lower values of the ROM in the Kangal dog once more suggest that this breed of dog does not seem to be in the scope of the race dog category.

In conclusion, this study has reported the angular values of the joints at natural anatomical posture and passive ranges of motion in Kangal dogs. The findings have revealed that both parameters are lower than those of the dog breeds examined in the literature. This suggests that the Kangal dog is not in the scope of the race dog category. The results presented may be used to assess the efficiency of medical and surgical procedures particularly on the Kangal dog breed.

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