Morphology of the Canine Stance

Ashley Goddard and Darryl Millis, D.V.M.

May 2, 2005

Abstract:

A study was conducted to measure the morphology of dogs while standing. The research accomplished by this project will create a basic database for canine morphology at a stance, including standing joint angles, limb circumferences, and bone lengths for the front and rear limbs. This database represents a variety of dogs of various sizes and breeds. The results indicated that dogs of different sizes have different limb lengths and circumferences, but do not have characteristically larger or smaller joint angles based on their respective size.

Introduction:

Previous studies have examined various aspects of canine orthopedics, and many studies have focused on specific joints or diseases. Goniometry has been developed to measure range of motion and was used to obtain the data for this study. Research has shown that some breeds and sizes of dogs are more prone to developing joint problems, with large dogs and certain breeds often having a greater risk. It is possible that larger dogs may have different joint angles as compared with smaller dogs, and this may make them more susceptible to certain conditions. However, there may not be a significant difference in the morphology of standing joint angles between small, medium, and large dogs because many factors play a role in joint problems and other differences exist between various breeds of dogs.

Previous literature regarding canine orthopedics has provided information for normal standing angles that are used to surgically fuse joints when necessary as a result of severe injury or disease. Some of these can be used to compare to the results found in

this study. The angles previously published were : carpus: 10-15° (equivalent to the carpal joint angle measured in this study plus 180°),[1] stifle: 135-140°,[2] and hock: 135-145°.[3] These angles were recommended for either immobilization of a joint or for fusing a joint, and are used to compare with our data.

The dogs used in this study included beagles, hounds, retrievers, and other large mixed-breed dogs. Individual breeds vary in their conformation because some dogs have different body shapes; for example, bulldogs have a chondrodystrophic body type with angular limb conformation, while others, such as greyhounds, have longer, straighter legs. Therefore, the dogs cannot be compared only by size.

In this study, standing angles and range of motion were obtained using a goniometer. Corresponding bone lengths and circumferences of the femur, tibia, metatarsals, humerus, antebrachium (combined radius and ulna) and metacarpals were also measured using a measuring tape. Limb circumference for each bone was determined at 50% of the bone length. Results were obtained from a variety of dog breeds and sizes to provide a broader range for the usefulness of the information obtained.

The purpose of this study, then, was to evaluate standing joint angles in dogs to establish standard reference information that can be used in future studies and research. I hypothesized that although there would significant differences in limb length and limb circumference, there would not be a significant difference in the morphology of standing joint angles between small, medium, and large dogs.

Experimental Procedure:

Since the purpose of this study was to create a standard, measurements were only made on healthy animals. Microsoft Excel was used to record and organize the data, shown in Figure 1. The procedure of measuring a dog began with selecting a side to measure and obtaining basic information of weight, age, and name. If the dog had one abnormal or injured leg, then the opposite normal side was chosen; otherwise, the right side was arbitrarily chosen.

(1) Standing Angles

The joint angles were recorded while the dog was standing in a normal position as squarely as possible, with each fore and rear limb symmetrically placed. The joints measured included the hip, stifle, hock, shoulder, elbow, and carpus. Figure 2 is a diagram of the angles that were measured. The same landmarks on the bones were used for measuring each time.

(2) Range of Motion

For the next set of measurements, each dog was placed on its side, so that the range of motion of the joints could be obtained. The dogs were kept as relaxed as possible so the limbs could be fully extended and flexed. Each joint was flexed and extended as far as was comfortable for the dog.

(3) Bone Measurements

In addition, bone lengths and 50% circumferences of the limb for each bone were measured. These bones included the femur, tibia, metatarsals, scapula, humerus, antebrachium, and metacarpals. A tape measure was used to obtain the length of the bone, then the midpoint was found at which the circumference was measured. The 50%

circumference was not obtained for the scapula due to the difficulty in accurately obtaining this measurement.

Results:

The Excel chart shows the measurements that were made for all the dogs. The dog's name, breed, age, weight, and the side the measurement was taken on are indicated. The joint angles for the hip, stifle, hock, shoulder, elbow, and carpus are shown for the standing angles. The next sheet shows the angles for maximum joint flexion and extension with the dog relaxed in lateral recumbency. The last sheet contains the measurements of the bone lengths and circumferences. Means and standard deviations were calculated to assess the variance of the data from the mean. For the standing angles, standard deviation ranged from 2.02 to 26.88. Standard deviation for joint flexion and extension joints ranged from 3.61 to 24.68. Bone lengths had relatively low variance, with standard deviation ranging from 0.17 to 6.42. To compare means by size, dogs were assigned to one of four weight categories, 20-30 lbs, 31-45 lbs, 46-60 lbs, and 61-100 lbs. From this, comparisons could be made between the results for different size dogs. For the joint angles (standing and flexed/extended), there does not appear to be a specific trend in any one category. All of the individual mean values are within approximately 15 degrees of the overall means, with most much less than that.

Discussion:

The mean standing joint angle measurements for each size category were similar, but there were some differences. The data were assessedusing standard deviations, which

showed that there was as much as 27 degrees difference in some of the measurements. This indicates that there were differences that may be explained by error or by other factors. The differences could be due to the individual differences in the dogs themselves or to the variety of breeds in each size category. This would not seem to be the case in the smallest dogs, however, because the 20-30 lb category is made entirely of beagles. The beagles' joints may be different from the larger hounds because they have shorter, more crooked legs than the large hounds with long legs. Therefore, differences should be expected between these dogs. The joint angles suggested by previous research are somewhat different from some of the averages in this study. The carpus differed by 16°,[1] the stifle: 7°,[2] and the hock: 6°.[3] There are possible explanations for these differences, including the difficulty encountered in obtaining some of the measurements. The procedure required the dog to stand still and allow measurements to be taken for several minutes. For most of the animals, this was possible but still required some effort. Another possibility is that previous authors may have used different breeds of dogs than were used in the present study. The most challenging step was usually laying the dog on its side and moving the joints in flexion and extension. Despite the fact that the dog was not using the limb to bear weight, the leg muscles still had tension that seemed to restrict full flexion or extension in some cases. If, for example, measurements could be obtained while the dog was sedated, then the joints would likely extend and flex further. However, one study using Labrador Retrievers has shown that goniometry is reliable and the measurements were not affected by sedation.[4] Data from this study on goniometry shows very similar values for flexion and some minor differences in values for extension.[4] The present study could be expanded on by using greater numbers of dogs and separating

dogs into categories based on breeds and observing any differences between breeds and various sizes.

Conclusion:

This information obtained in this study provides a standard for canine standing joint angles and range of motion. Each of the standing angles was measured for 14 dogs along with the flexion and extension of each joint. This information, along with bone lengths and circumferences may be useful formaking canine splints or evaluating a dog for fusion of a particular joint. Although some of the standing angles differed somewhatfrom those in previous literature, they are generally similar and may reflect the fact that individual dogs and breeds have slightly different morphologies. It was concluded that there was not a trend in the means of the joint measurements based on the dogs' sizes, but bone length and limb circumference increase with the size of the dog. Although some data of this nature exist within other research studies, this study is useful in that it focuses specifically on making a standard that can be used in future veterinary orthopedic research.

References Cited:

1. Brinker, Piermattei, and Flo. *Small Animal Orthopedics and Fracture Repair*, 3rd Edition. W. B. Saunders Company, 1997. pp.350-351.
2. Brinker, Piermattei, and Flo. *Small Animal Orthopedics and Fracture Repair*, 3rd Edition. W. B. Saunders Company, 1997. p.575.

3. Brinker, Piermattei, and Flo. *Small Animal Orthopedics and Fracture Repair*, 3rd Edition. W. B. Saunders Company, 1997. p.631.

4. Jaegger G, Marcellin-Little DJ, Levine D. Reliability of goniometry in Labrador Retrievers. AJVR 2002;83[7]: pp.979-986.

Figure 1

Standing Joint Angles

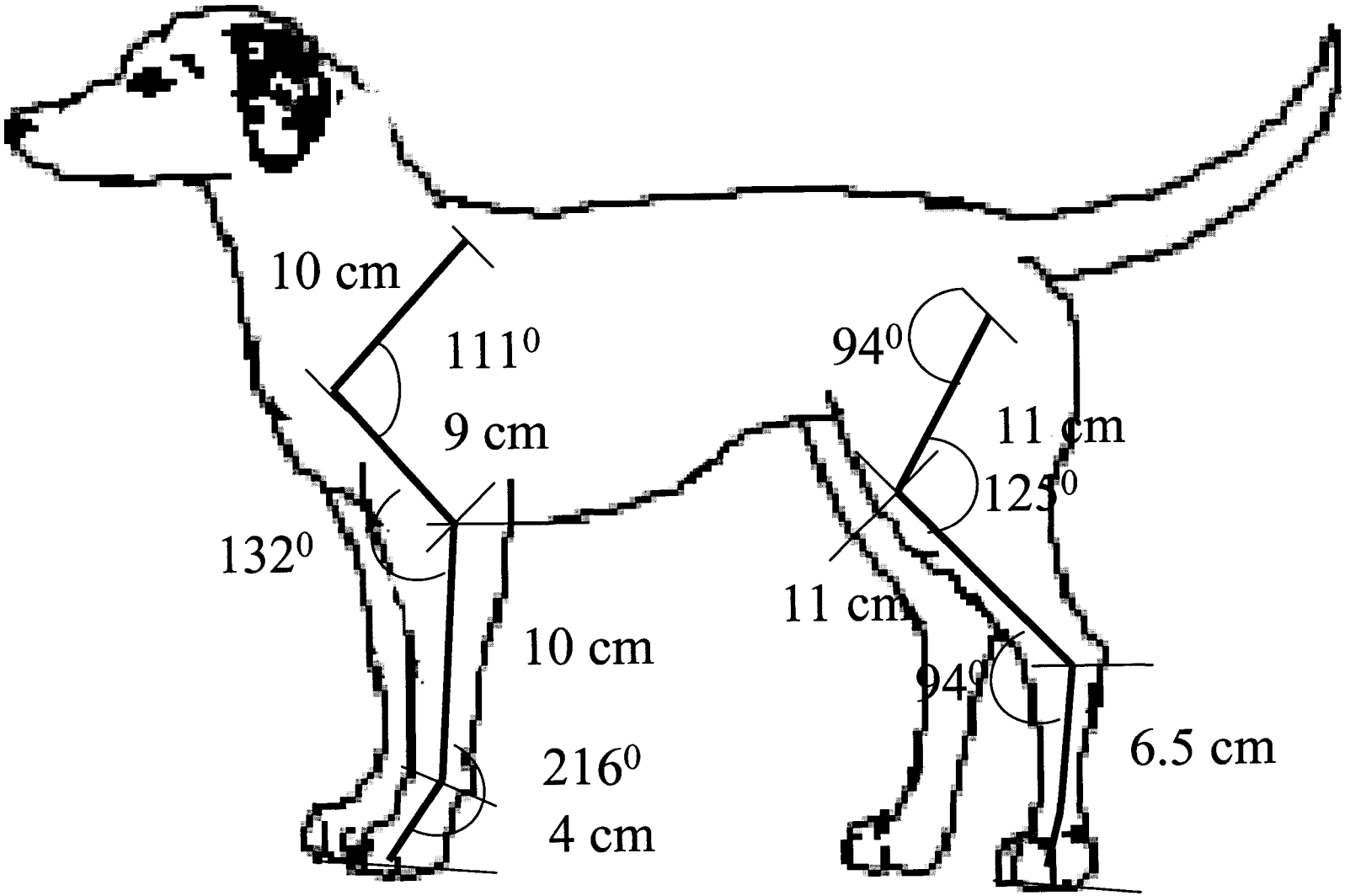
Dog Name	Breed	Age	Side	Weight	Hip	Stifle	Hock	Shoulder	Elbow	Carpus	Length (cm)	Height (cm)
Sally	beagle	7	R	20	100	136	121	115	139	217	46	33
Joe	beagle	7	R	28	85	112	88	105	130	201	50	32
Jim	beagle	6	R	28	105	135	115	108	123	210	57.5	39
Zeb	beagle	1	R	28	85	117	133	115	135	235	57	37
Sam	beagle	6	R	33	80	105	125	105	138	220	56	36.5
Gizmo	terrier x	2	L	36	80	119	146	135	155	192	57	51
Sara	Golden R.	4	R	43	107	125	121	146	140	211	67	52
Elvis	Hound	8	R	47	100	130	120	122	150	205	68	51
Jaguar	Hound	2	L	47	100	140	144	122	147	225	68	48.5
Madge	Hound	8	L	58	93	141	149	128	135	210	60	47
Copper	Lab. R.	2	R	77	132	154	154	145	151	190	80.5	63
Bandit	Grt Pyran.	10	R	100	70	117	130	107	151	215	95	72
Chestnut	hound	5	R	83	105	141	145	115	140	225	81	67
Bailey	rott/dob	8	R	100	120	110	137	120	135	205	103	79
Standard Deviation	20-30 lbs				10.31	12.30	19.03	5.06	6.90	14.41	5.59	3.30
	30-45 lbs				15.59	10.26	13.43	21.22	9.29	14.29	6.08	8.67
	45-60 lbs				4.04	6.08	15.50	3.46	7.94	10.41	4.62	2.02
	>60 lbs				26.87	20.53	10.34	16.40	8.06	14.93	11.03	6.90
			Means: Overall		95	128	129	121	141	211	64	47
			20-30 lbs		94	125	114	111	132	216	53	35
			30-45 lbs		89	116	131	129	144	208	60	47
			45-60 lbs		98	137	138	124	144	213	65	49
			> 60 lbs		101	136	142	126	151	203	88	68

Dog Name	Breed	Weight	Extended Hip	Flexed Hip	Extended Stifle	Flexed Stifle	Extended Hock	Flexed Hock	Extended Shoulder	Flexed Shoulder	Extended Elbow	Flexed Elbow	Extended Carpus	Flexed Carpus
Sally	beagle	20	166	51	148	32	163	66	144	55	130	28	190	28
Joe	beagle	28	115	28	165	45	155	35	115	60	122	15	200	30
Jim	beagle	28	155	50	165	35	175	55	132	75	145	15	195	21
Zeb	beagle	28	150	35	165	55	175	85	140	62	170	20	185	12
Sam	beagle	33	120	40	150	55	157	70	155	65	155	30	197	27
Gizmo	terrier x	36	145	55	157	30	175	61	164	77	150	35	225	21
Sara	Golden R.	43	135	36	152	35	156	28	135	54	157	15	192	20
Elvis	Hound	47	126	49	165	40	185	60	160	58	165	20	206	36
Jaguar	Hound	47	174	60	154	35	172	34	167	72	159	24	203	27
Madge	Hound	58	140	50	145	43	155	75	148	75	169	37	193	29
Copper	Lab. R.	77	159	52	150	46	175	80	165	70	157	30	200	32
Bandit	Grt Pyran.	100	115	45	172	65	175	90	143	75	145	45	240	55
Chestnut	Hound	83	120	57	150	35	182	77	152	61	171	30	190	42
Bailey	rott/dob	100	110	35	115	33	148	70	125	80	135	55	192	45
Standard Deviation:		20-30 lbs	22.04	11.34	8.50	10.44	9.80	20.90	12.84	8.52	21.11	6.14	6.45	8.14
		30-45 lbs	12.58	10.02	3.61	13.23	10.69	22.11	14.84	11.50	3.61	10.41	17.79	3.79
		45-60 lbs	24.68	6.08	10.02	4.04	15.04	20.74	9.61	9.07	5.03	8.89	6.81	4.73
		>60 lbs	22.38	9.54	23.57	14.66	15.03	8.30	16.80	8.10	15.53	12.25	23.40	9.47
		Overall	138	46	154	42	168	63	146	67	152	29	201	30
		20-30 lbs	147	41	161	42	167	60	133	63	142	20	193	23
		30-45 lbs	133	44	153	40	163	53	151	65	154	27	205	23
		45-60 lbs	147	53	155	39	171	56	158	68	164	27	201	31
		>60 lbs	126	47	147	45	170	79	146	72	152	40	206	44

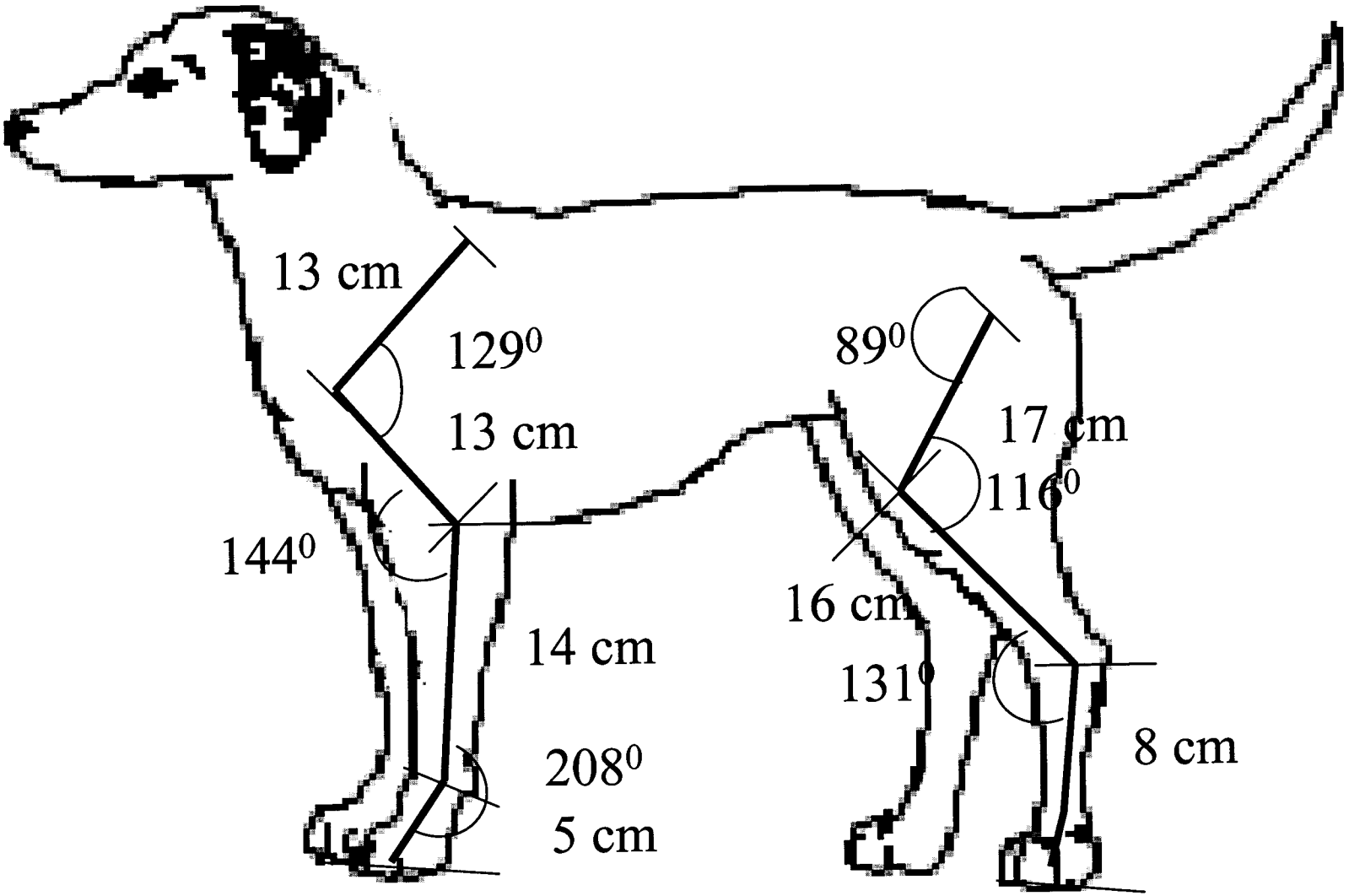
Dog Name	Breed	Weight	Scapula length (cm)	Humerus Length (cm)	Humerus 50% Circumference (cm)	Antebrachium Length (cm)	Antebrachium 50% Circumference (cm)	Metacarpals Length (cm)	Metacarpals 50% Circumference (cm)	Femur Length (cm)	Femur 50% Circumference (cm)	Tibia Length (cm)	Tibia 50% Circumference (cm)	Metatarsals Length (cm)	Metatarsals 50% Circumference (cm)
Sally	beagle	20	10	9	17	10	10	4	7.5	11	25.5	11	11	6.5	7
Joe	beagle	28	10	10	18	10	10.5	3	9	13.5	26	12	11	5	7.25
Jim	beagle	28	11.5	11	20	12	11.5	4	8.5	15.5	27	12	13	7	7.5
Zeb	beagle	28	10	10.5	19	11	9.25	3.5	8.5	14.5	25.5	13	11	7	8
Sam	beagle	33	10.5	10.5	18.5	11	10	4	8.5	15.5	26.5	13.5	13	6	8
Gizmo	terrier x	36	14	11.5	20	15	12	6	10	17	29	15	12	9	9
Sara	Golden R.	43	15	17	28	17	12.2	6	9.7	18.5	40.5	18	13.5	10	9
Elvis	Hound	47	16	17	26.1	18	11	7.5	10	19.5	34.3	17	13.3	11	9.7
Jaguar	Hound	47	15	15	17	17	11	6.5	9.7	17	29.7	17	13.5	10	8.9
Madge	Hound	58	14	16.5	25	16.5	13	5.5	10	19	37	20	15	9	9
Copper	Lab. R.	77	16	19.5	35	22	15.8	7.5	12	22.5	48.5	23	17.5	12.5	11
Bandit	Grt Pyran.	100	20	17	27	26	20	7	15	34	54	21	17	13	15
Chestnut	Hound	83	19	19	24	21	15.5	7	11.5	22	39.5	23	16	12	11
Bailey	rott/dob	100	24	22	33	23	17.5	7	14	25	52	26	18	13	12
Standard Deviation		20-30 lbs	0.75	0.85	1.29	0.96	0.94	0.48	0.63	1.93	0.71	0.82	1.00	0.95	0.43
		30-45 lbs	2.36	3.50	5.11	3.06	1.22	1.15	0.79	1.50	7.47	2.29	0.76	2.08	0.58
		45-60 lbs	0.82	0.95	4.84	0.63	0.98	0.85	0.17	1.08	4.56	1.41	0.79	0.82	0.37
		>60 lbs	3.30	2.06	5.12	2.16	2.06	0.25	1.65	5.57	6.42	2.06	0.85	0.48	1.89
	Means:	Overall	15	15	23	16	13	6	10	19	35	17	14	9	9
		20-30 lbs	10	10	19	11	10	4	8	14	26	12	12	6	7
		30-45 lbs	13	13	22	14	11	5	9	17	32	16	13	8	9
		45-60 lbs	15	16	23	17	12	7	10	19	34	18	14	10	9
		> 60 lbs	18	18	31	24	18	7	14	28	51	22	17	13	13

Figure 2

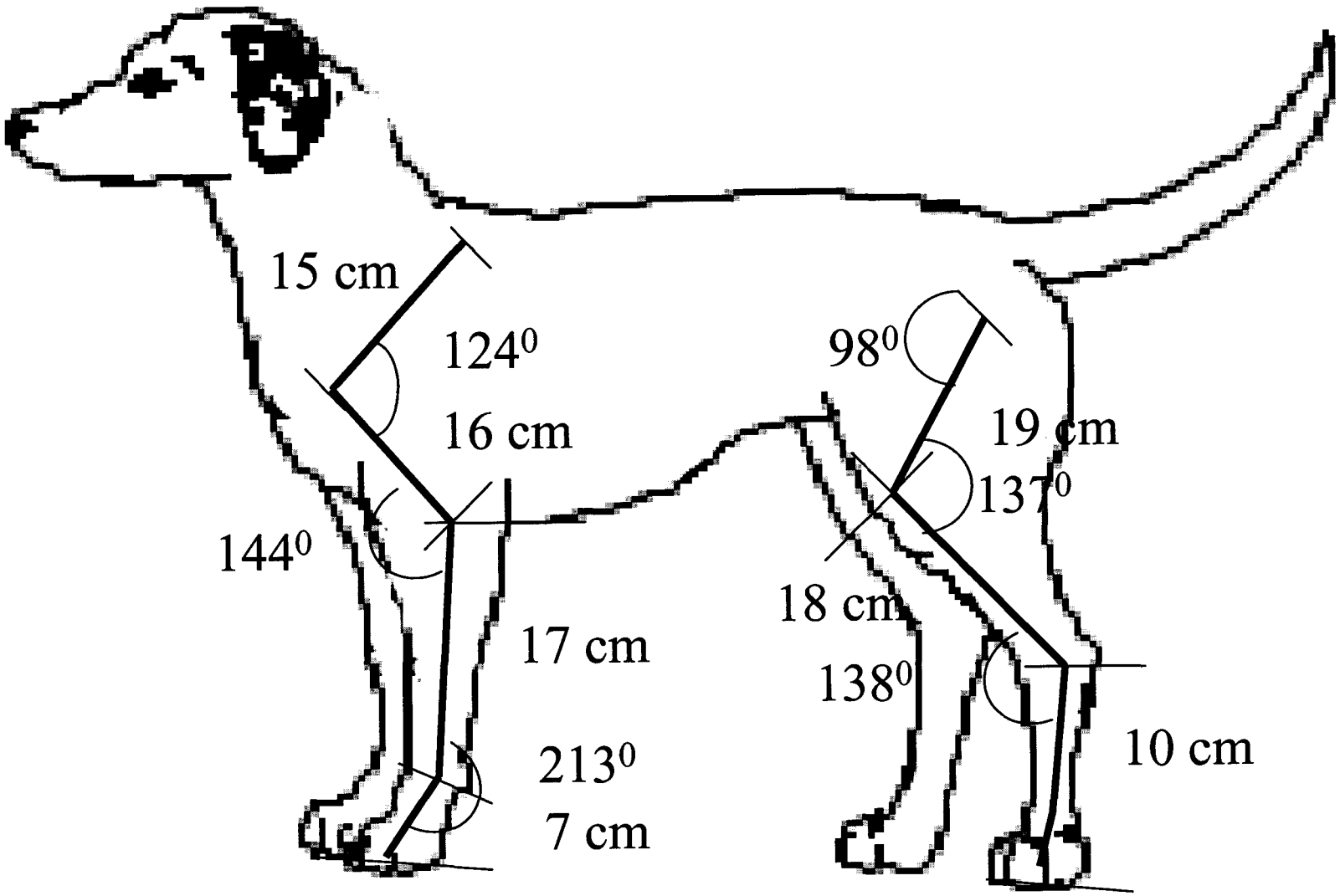
20-30 lb dogs



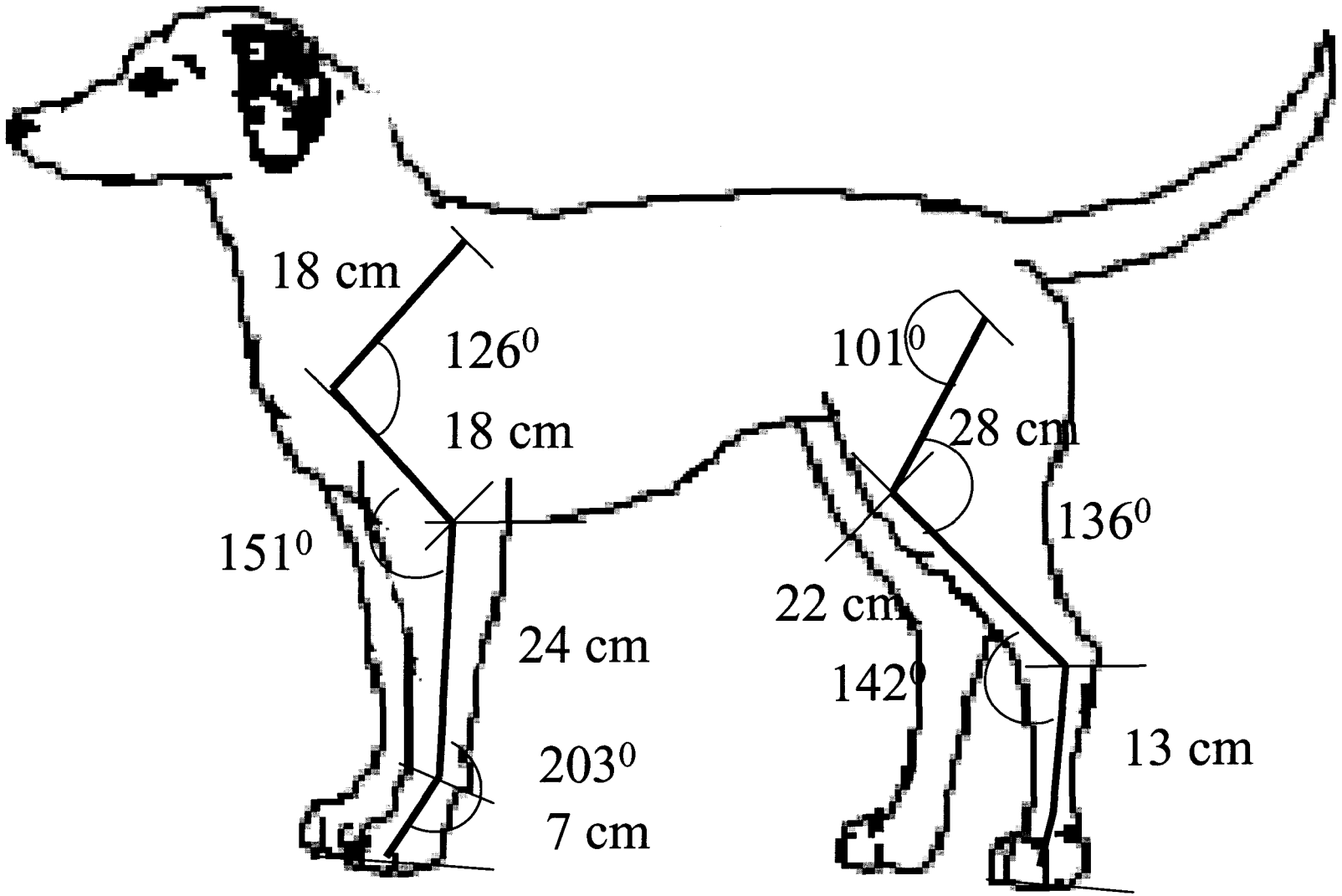
30-45 lb dogs



45-60 lb dogs


15 cm
124⁰
16 cm
144⁰
17 cm
213⁰
7 cm
98⁰
19 cm
137⁰
18 cm
138⁰
10 cm

> 60 lb dogs


18 cm
126⁰
18 cm
151⁰
24 cm
203⁰
7 cm
101⁰
28 cm
136⁰
22 cm
142⁰
13 cm