

A COMPARISON OF X-RAY MORPHOMETRICAL PARAMETERS IN ROTTWEILERS AND OTHER DOG BREEDS IN CASE OF HIP DYSPLASIA

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Summary. Investigations were carried out at the Clinical Institute of the Faculty of Veterinary Medicine of the Latvian University of Agriculture. The aim and objectives of the investigation were to determine and compare the use of some x-ray morphometrical parameters of hip dysplasia in young Rottweilers and other dog breeds. We have determined the x-ray morphometrical parameters used in diagnostics of hip dysplasia: Norberg angle (X1), inclination angle (X2), tangential angle (X3), location of geometrical centre of femoral head (X4), width of the lateral joint gap (X5), width of the medial joint gap (X6), and distraction index (X7). We have investigated agreement or differences of x-ray morphometrical parameters in Rottweilers and other breed dogs. Radiography was made at a ventrodorsal projection. The obtained data of x-ray morphometrical parameters were used for analysis. In case of hip dysplasia, differences of some parameters were established within the framework of the breeds, and differences of some x-ray morphometrical parameters between Rottweilers and other dog breeds.

Key words: hip dysplasia, breed, dog, measurements.

ROTVEILERIŲ IR KITŲ VEISLIŲ ŠUNŲ KLUBO SĄNARIO RENTGENOMORFOMETRINIŲ PARAMETRŲ PALYGINIMAS DISPLAZIJOS ATVEJU

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Santrauka. Tyrimai atlikti Latvijas zemes ūķio universitātes Veterinārines medicīnas fakultātes Klinikināme institūte. Tyrimu tikslas – nustatyti bei palyginti kai kuriuos rentgeno morfometrinius parametrus diagnozuojant klubo sąnario displazijā jauniems rotveilerių ir kitų veislių šunims. Diagnozuojant klubo sąnario displazijā tirti rentgeno morfometriniai parametrai: Norbergo kampas (X1), nuolydžio kampas (X2), tangentinis (liestinis) kampas (X3), šlaunikaulio galvutės geometrinio centro padėtis (X4), sąnario lateralinio tarpo atstumas (X5), sąnario medialinio tarpo atstumas (X6) ir distrakcijos indeksas (X7). Palyginti gauti parametrai tarp dešiniojo ir kairiojo klubo sąnario, taip pat palyginti rotveilerių ir kitų veislių šunų parametrų vidurkiai. Išanalizavus gautus rezultatus, nustatyti skirtumai tarp kairiojo klubo sąnario tangentinio kampo ir kairiojo medialinio sąnario tarpo atstumo. Be to, nustatytas skirtumas tarp dešiniojo ir kairiojo klubo sąnario medialinio sąnario tarpo atstumo kitų veislių šunims.

Raktažodžiai: klubo sąnario displazija, veislė, šuo, matavimai.

Introduction. Hip dysplasia (HD) is a multifactorial, genetically determined biomechanical development disease (usually bilateral), characterised by inadequacy formed hip joints that is later accompanied by secondary degenerative joint arthrosis. Different forms of hip dysplasia occur in various species of animals including human beings, but as an important clinical problem it is just in dogs because the hip joints form an anatomical structure that holds the caudal part of dog's body on two spherical surfaces – femoral heads, and they are involved into various body movements and positions (Morgan; 1988; Powers et al., 2004).

Also, such a factor shows evidence of the importance of this problem that heredity of HD has been established in 14 generations (Белов и др.1990).

As Brass and Paatsama (1985) reasonably had pointed out, this disease most often had affected large fast growing breeds of dogs.

Morgan's (1992) studies make it apparent that, firstly, hip joints in 4-8 months old dogs are not completely developed and that is why x-ray diagnostic parameters may

be different, and, secondly, HD clinical and radiographic picture in dogs may be similar to other hip joint diseases, e. g. changes of traumatic nature, dystrophies, abnormalities caused by Leg-Perthes disease and others.

Taking into consideration these factors, several criteria are developed and suggested for analyzing and estimating radiograms. They are mainly based on measurements of the correlated position and angles of hip acetabulum, femoral head and femoral neck in case of normal condition and dysplasia. It is of great importance to investigate those parameters in young dogs because the changes associated with the hip dysplasia are not always apparent radiographically. The aim of the investigation was to determine the following morphometrical parameters of the hip joint: Norberg angle (X1), femoral neck inclination angle (X2), location of geometrical centre of femoral head in relation to the sagittal line parallel to the longitudinal axis (centre line) of the body starting from the acetabulum craniodorsal side (X3), tangential angle (X4), width of the lateral joint gap (X5), width of the medial joint gap (X6), distraction index (X7), and to find out the

statistical significance of numerical values in young Rottweilers and other dog breeds.

Material and methods. The investigations were carried out at the Department of Surgery of the Faculty of Veterinary Medicine of the Latvian University of Agricul-

ture. Sixty one dogs of different breeds, sex and age were used (Table 1), which showed a syndrome of lameness of different degree of uncertain etiology of fore and hind limbs.

Table 1 Breed, sex and age of the dogs used for examinations

Breed	Sex		Age		Total
	fem.	male.	under 1 year	over. 1 year	
Rottweiler	9	27	32	4	36
Mastino Napoletano	1	4	4	1	5
Čow Čow	1	4	4	1	5
German Sheperd	2	3	3	2	5
Caucasian Sheepdog		3	2	1	3
Staffordshier Terrier		2		2	2
Landseer		1		1	1
Doberman Pinscher		1		1	1
Bull Terrier		1	1		1
Mid-Asian Sheepdog	1		1		1
Bullmastiff	1			1	1
Total	15	46	47	14	61

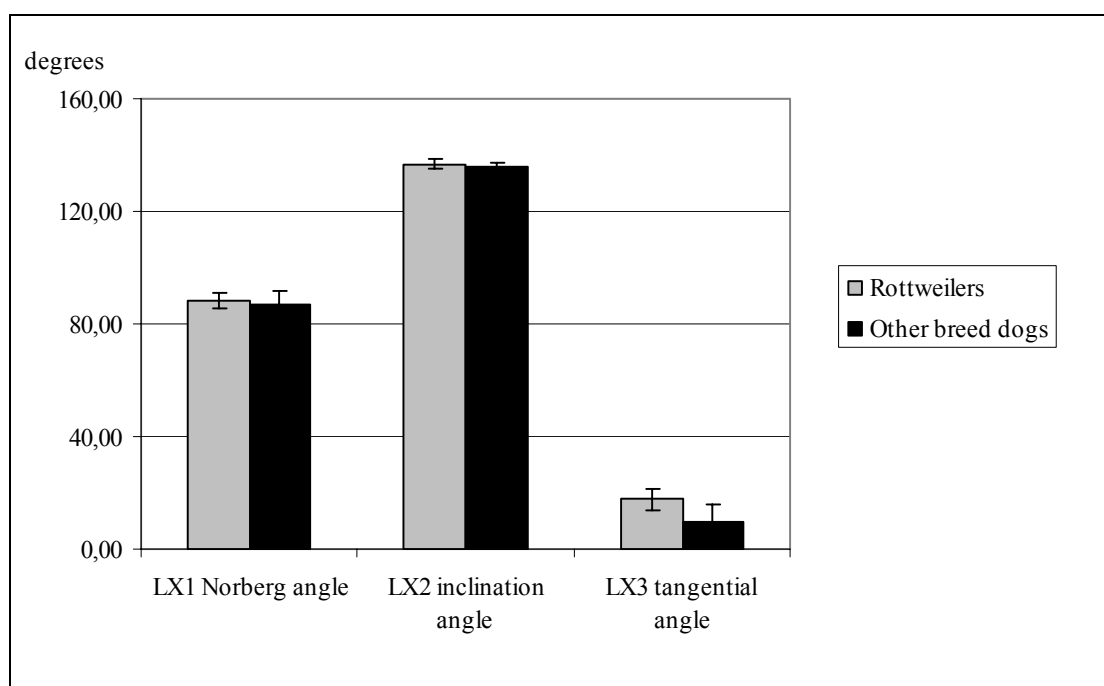


Figure1. A graphical display of the mean values LX1, LX2, LX3 and standard error of morphometrical parameters of the right hip joint in Rottweilers and other breed dogs

Dogs are radiographically examined by applying PHILIPS MCD 125 Nr. 0 41 WB 18E01 x-ray equipment in compliance with the requirements of the International Canine Federation (FCI).

For this purpose, dogs were anesthetized by administering intravenously ketamine 100 mg/ml and diazepam 5 mg/ml combination 1 ml per 10 kg of body weight. After that, the dog was fixed on its back and radiography was made at a dorsoventral projection with stretched hind legs in parallel position.

As it is mentioned in the aim of the work, radio-

graphical parameters from X1 –X7 of the hip joints were determined in radiograms. The measurement results are arranged according to the dog breeds (Rottweilers and other dog breeds) as well as all the parameters are grouped for the right and left hip joint separately of the examined dogs. The aim of the further calculation was to find out whether the difference of the mean values between the right (LX1 – LX7) and left (KX1 –KX7) hip joint parameters is significant between Rottweilers and other dog breeds.

The statistical data processing was performed by Mi-

Microsoft Excel – 97 computer program. The arithmetical mean, mean standard error and Student T- test were calculated in order to evaluate the confidence of difference of the obtained results (Arhipova, Bălița, 2003; Christensen, 1996).

Data were considered different when the confidence level was lower than 0.05 ($p < 0.05$ or $P = 95\%$).

Results. A comparison of the mean values of morphometrical parameters of right hip joint between Rott-

weilers and other dog breeds suffering from HD.

In Rottweiler breed dogs, hip dysplasia of the right hip joint was established in 24 dogs (67 % of cases) out of 36 examined animals, but in other breeds of dogs the right hip dysplasia was found in 17 dogs (68 % of cases) out of 25 examined animals.

The mean values and standard error of the parameters from LX1 – LX7 of the right hip joint in Rottweilers and other dog breeds are given in Table 2.

Table 2. The mean values and standard error of morphometrical parameters of the right hip joint in Rottweilers and other breeds of dogs

Parameter	Unit of measurement	Rottweilers (n=24)	Other breed dogs (n=17)	Probability P
		Mean \pm Standard error	Mean \pm Standard error	
X0 age	months	8.18 \pm 0.93	11.50 \pm 1.76	94%
LX1 Norberg angle	degrees	88.12 \pm 2.57	86.58 \pm 5.27	60%
LX2 inclination angle	degrees	136.86 \pm 1.90	135.67 \pm 1.89	67%
LX3 tangential angle	Degrees	17.70 \pm 3.61	9.82 \pm 6.20	86%
LX4 geometrical centre placement of the CFH	mm	0.42 \pm 0.67	- 0.38 \pm 1.09	73%
LX5 lateral joint gap	mm	1.70 \pm 0.20	1.41 \pm 0.22	82%
LX6 medial joint gap	mm	2.86 \pm 0.22	3.06 \pm 0.29	70%
LX7 distraction index		0.44 \pm 0.07	0.31 \pm 0.03	94%

The mean values of probability (P) level is to be valued if it is 95% and more.

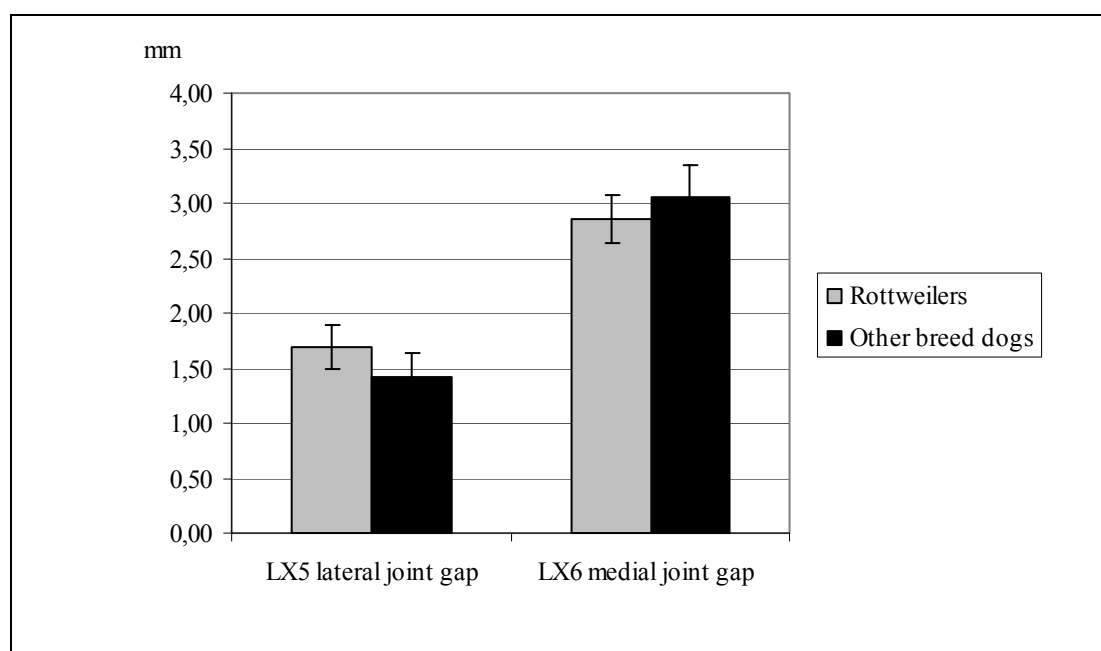


Figure 2. A graphical display of the mean values LX5, LX6 and standard error of morphometrical parameters of the right hip joint in Rottweilers and other breed dogs

When calculating the average age in Rottweiler breed dogs with HD diagnosis, it is apparent that the average age of this breed of dogs is 8.2 months (standard error \pm 0.93), while in other breed dogs with HD diagnosis the average age is 11.5 months (standard error \pm 1.76).

By using T-test, it was established that Rottweiler breed dogs with a probability $P = 94\%$, that is close to

significant, with HD are younger than those of other breeds.

Analysis of the mean indices of the following parameters: LX1 (Norberg angle), LX2 (inclination angle), LX3 (tangential angle), LX4 (geometrical centre placement of the CFH), LX5 (lateral joint gap), LX6 (medial joint gap) has shown that there are no significant differences of the

mean values of parameters between Rottweilers and other dog breeds with HD. (Estimating by P- value percentage).

Calculating the mean value by variable LX7 (distraction index), it is found out that in Rottweiler breed dogs $X_{\text{mean}} = 0.45$ (dispersion 0.09). By using T-test, it is established that with a probability $P=94\%$, that is close to significant, in Rottweiler breed dogs the parameter LX7 (distraction index) in the right hip joint is more expressed in comparison with LX7 (distraction index) in other breed dogs.

A graphical display of the mean values of morphometrical parameters and standard error of the right hip joint in Rottweilers and other dog breeds in case of hip dysplasia

The graphical display of morphometrical parameters is made by combining together numerical similar parameters because the separate parameter numerical values are radically different and their visual evaluation is difficult

to notice if they are placed in one graphical display.

A comparison of the mean values of the morphometrical parameters of the left hip joint in Rottweilers and other dog breeds.

A graphical display of the mean values of morphometrical parameters and standard error of the left hip joint in Rottweilers and other dog breeds in case of hip dysplasia

An analogous division of the left hip joint was carried out. In Rottweiler breed dogs, hip dysplasia (HD) of the left hip joint was found in 23 dogs (64% of cases) out of 36 examined animals, but in other breed of dogs a unilateral HD was observed in 16 dogs (16% of cases) out of 25 examined dogs.

The mean values and standard error of the evaluated parameters KX1 to KX7 are presented in Table 3.

Table 3. The mean values and standard error of the left hip joint

Parameter	Unit of measurement	Rottweilers (n=23)	Other breed dogs (n=16)	Probability P
		Mean \pm Standard error	Mean \pm Standard error	
KX1 Norberg angle	degrees	90.56 \pm 2.48	88.68 \pm 4.16	65%
KX2 inclination angle	degrees	136.50 \pm 2.88	138.63 \pm 2.28	72%
KX3 tangential angle	degrees	22.56 \pm 4.20	6.37 \pm 6.02	97%
KX4 geometrical centre placement of the CFH	mm	- 0.10 \pm 0.61	0.37 \pm 1.02	65%
KX5 lateral joint gap	mm	1.94 \pm 0.23	1.78 \pm 0.29	67%
KX6 medial joint gap	mm	2.88 \pm 0.17	2.20 \pm 0.13	99%
KX7 distraction index		0.30 \pm 0.05	0.27 \pm 0.07	62%

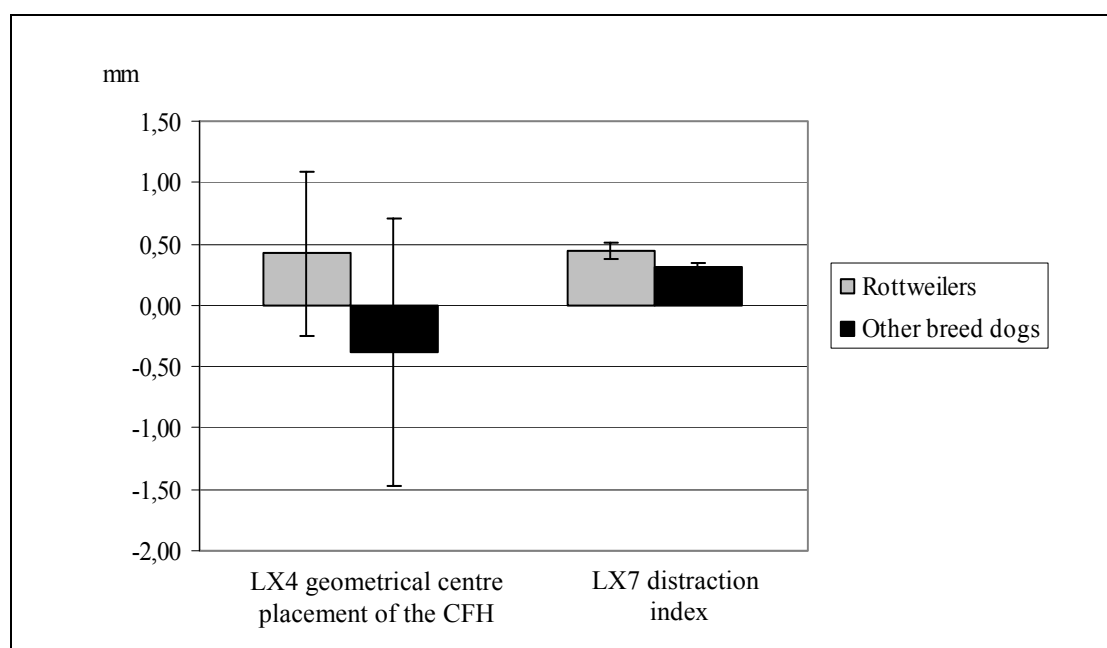


Figure 3. A graphical display of the mean values LX4, LX7 and standard error of morphometrical parameters of the right hip joint in Rottweilers and other breed dogs

Analysis of the “mean” values of variables KX1 (Norberg angle), KX2 (inclination angle), KX4 (geometrical centre placement of the CFH), KX5 (lateral joint gap), KX7 (distraction index) and estimation of the differences between the breeds show evidence that there are no significant differences of the above mentioned mean indices between Rottweiler breed and other breed dogs.

Calculating the mean value by variable KX3 (tangen-

tial angle) is obvious that in Rottweiler breed dogs $X_{\text{mean}}=22.56$ (dispersion 406.07), but in other breed dogs $X_{\text{mean}}=6.37$ (dispersion 581.45). By using T-test, it is established that with a probability $P=97\%$, in Rottweiler breed dogs tangential angle is larger in comparison with that of other dog breeds (Table 4).

Table 4. A comparison of tangential angle (KX3) of the left hip joint between Rottweilers and other breed dogs by applying T-test

Indices	Rottweilers KX3	Other breed dogs KX3
Mean	22.56522	6.375
Variance	406.0751	581.45
Observations	23	16
df	29	
t Stat	2.20329	
P(T<=t) two tail	0.035671	
t Critical	2.045231	

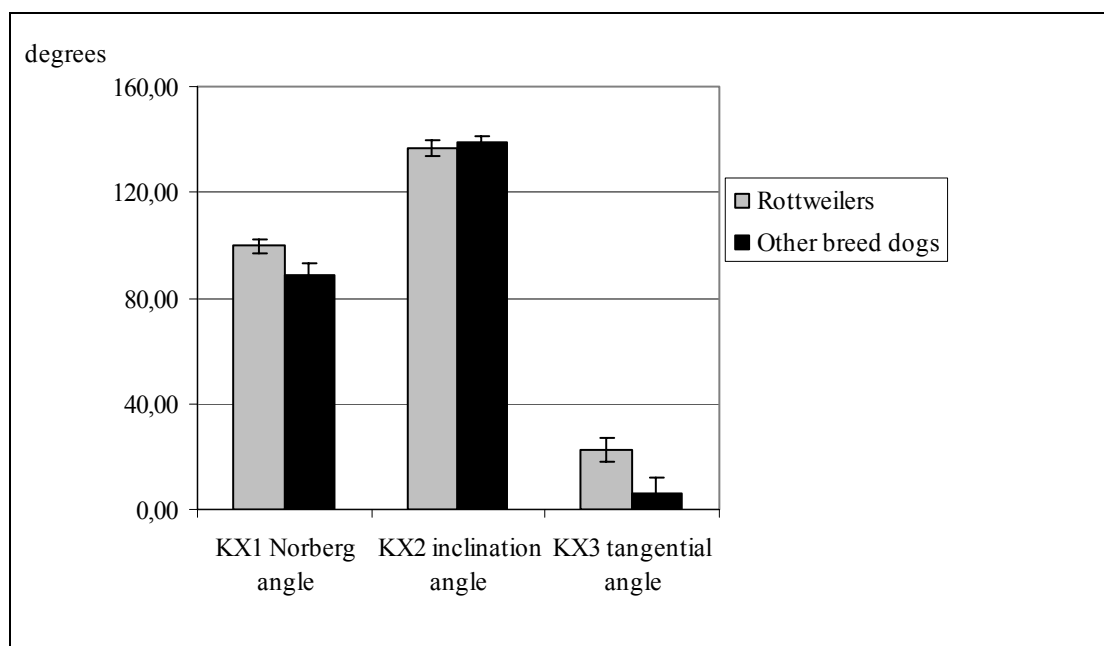


Figure 4. A graphical display of the mean values KX1, KX2, KX3 and standard error of morphometrical parameters of the left hip joint in Rottweilers and other breed dogs

Calculating the mean value by variable KX6 (medial joint gap), is apparent that in Rottweiler breed dogs $X_{\text{mean}}=2.88$ with dispersion 0.26. By using T-test, it is established that there is a significant difference with a probability $P=99\%$, i.e. in Rottweiler breed dogs the width of medial joint gap in case of HD is larger in comparison with that of other dog breeds (Table 5).

A comparison of the mean variables of the right and left hip joints in Rottweilers and other dog breeds.

A graphical display of morphometrical parameters and standard error of the right and left hip joint in Rottweilers in case of hip dysplasia.

In order to make these calculations, data of the right

and left hip joints in Rottweilers and other dog breeds are used (Table 2 and 3).

The mean values of parameters of the right and left hip joint of Rottweiler breed dogs with HD were compared, and there were not found significant differences between Norberg angle (KX1 un LX1), inclination angle (KX2 un LX2), tangential angle (KX3 un LX3), geometrical centre placement of the CFH (KX4 un LX4), width of the lateral joint gap (KX5 un LX5) and width of the medial joint gap (KX6 un LX6) parameters of the above mentioned dog breeds(P value level was lower than 95%).

Table 5. A comparison of the width of medial joint gap (KX6) of the left hip joint between Rottweilers and other breed dogs by applying T-test

Indices	Rottweilers KX6	Other breed dogs KX6
Mean	2.886957	2.206667
Variance	0.692095	0.26781
Observations	23	15
df	36	
t Stat	3.106863	
P(T<=t) two tail	0.003679	
t Critical	2.028091	

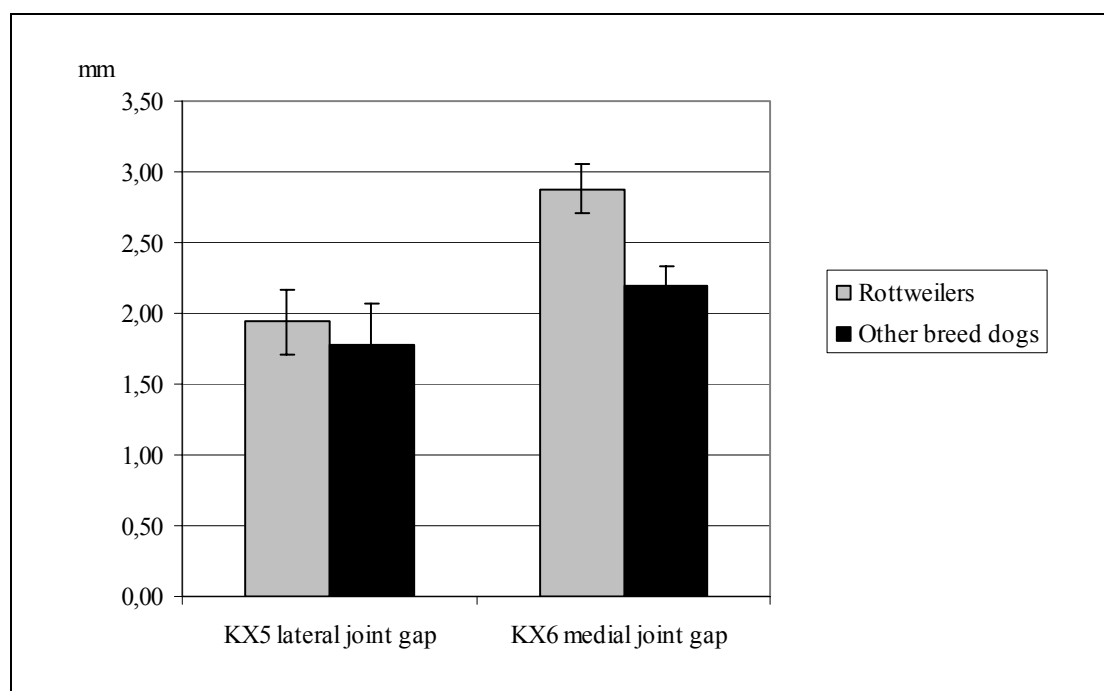


Figure 5. A graphical display of the mean values KX5, KX6 and standard error of morphometrical parameters of the left hip joint in Rottweilers and other breed dogs

It should be pointed out that comparing the mean parameters of distraction index (KX7 and LX7) it is apparent that $KX7_{men} = 0.30$ with a dispersion 0.04, but $LX7_{men} = 0.45$ with a dispersion 0.09. The results show that the difference with $P=93\%$ is close to significant between the right and left hip joint, i.e. in Rottweiler breed dogs, distraction index (LX7) of the right hip joint is larger than the left hip joint distraction index (KX7) in case of HD.

Obviously, distraction index requires further investigations and much more larger number of animals to assert precisely that a higher value of this parameter in case of HD is a typical clinical (morphometrical) HD sign in Rottweiler breed dogs or it is not.

A comparison of a mean variables of the right and left hip joint in other breed dogs

A graphical display of morphometrical parameters and standard error of the right and left hip joint in other dog breeds in case of hip dysplasia.

In order to obtain these calculations, data about the right and left hip joint in other dog breeds affected with HD were used (Table 2 and 3).

The compared mean values of Norberg angle (KX1

and LX1), inclination angle (KX2 un LX2), tangential angle (KX3 un LX3), geometrical centre placement of the CFH (KX4 un LX4), width of the lateral joint gap (KX5 un LX5) and distraction index (KX7 and LX7) show evidence that there are no significant differences between the mean parameters of the right and left hip joint in other breeds of dogs (P value level was lower than 95%).

Comparing the mean parameters of the width of medial joint gap (KX6 and LX6), it is seen that $KX6_{men} = 2.20$ with a dispersion 0.26, and $LX6_{men} = 3.06$ with a dispersion 1.34, and there is a significant difference of the medial joint gap (0.86 mm) with $P=995$ between the right and left hip joint, i.e. in other dog breeds, in case of HD the width of medial joint gap of the right joint is wider than that of the left hip joint (Table 6).

Discussion. From the obtained results about the right hip joint, it is established that in case of hip dysplasia (HD) in Rottweiler breed dogs, the parameter LX7 (distraction index of the right hip joint) with a probability $P=945$, that is close to significant, is more expressed than in other breeds of dogs (Table 2).

Table 6. A comparison of mean variables of the medial joint gap of the right and left hip joint in other breed dogs

Indices	Other breed dogs LX6	Other breed dogs KX6
Mean	3.0625	2.206667
Variance	1.3465	0.26781
Observations	16	15
df	21	
t Stat	2.679584	
P(T<=t) two tail	0.007015	
t Critical	1.720744	

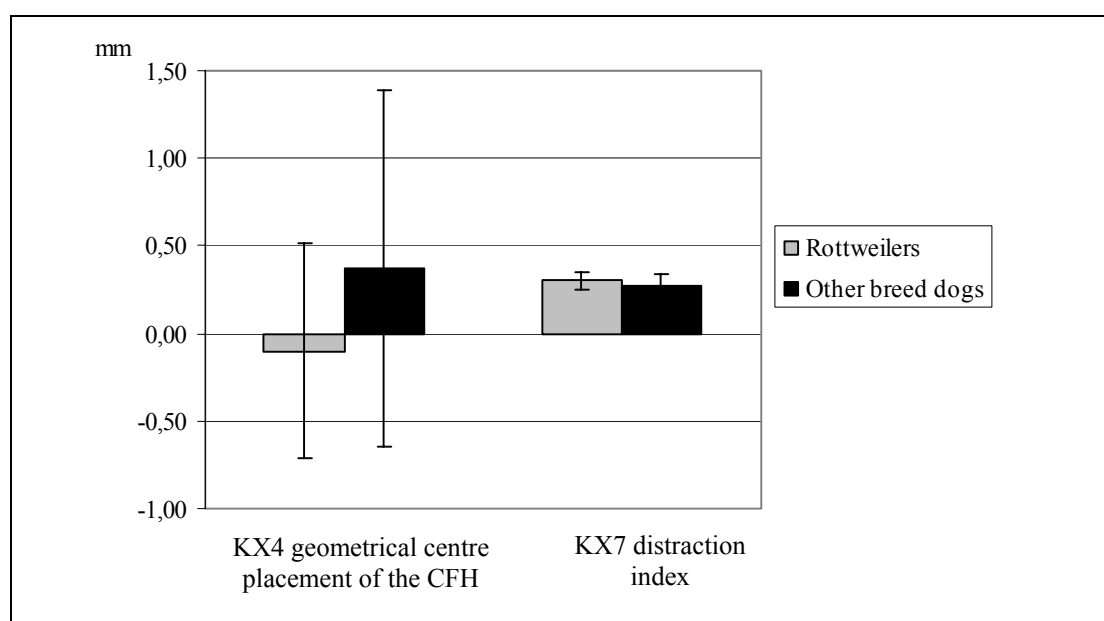


Figure 6. A graphical display of the mean values KX4, KX7 and standard error of morphometrical parameters of the left hip joint in Rottweilers and other breed dogs

From the obtained results about the left hip joint it is found out that there is a significant difference in parameters KX3 (tangential angle). The results show that in Rottweilers in case of HD with a probability $P=97\%$ the tangential angle is larger than that in other breeds of dogs (Table 3). The parameter KX6 (medial joint gap) with a probability $P=99\%$ is different significantly, i.e. in Rottweiler breed dogs the medial joint gap is larger in comparison with other dog breeds (Table 3).

It should be pointed out that comparing the mean parameters of distraction index (KX7 and LX7) it is obvious that $KX7_{\text{mean}} = 0.30$ with a dispersion 0.04, but $LX7_{\text{mean}} = 0.45$, with a dispersion 0.09. The results show that the difference of distraction index with $P=93\%$ is close to significant between the right and left hip joint, i.e. the right hip joint distraction index (LX7) in Rottweiler breed dogs is larger than the left hip joint distraction index (KX7).

Comparing the mean parameters of the medial joint gap (KX6 and LX6), it is obvious that $KX6_{\text{mean}} = 2.20$ with a dispersion 0.26 and $LX6_{\text{mean}} = 3.06$ with a dispersion 1.34, and a significant difference of medial joint gap (0.86 mm) with $P=99\%$ is established between the

right and left hip joint, i.e. in other dog breeds in case of HD the medial joint gap of the right hip is wider than the medial joint gap of the left hip.

Tangential angle (X3). Hauptman et al. (1985) have pointed out to correlation between the subluxation force and craniodorsal side slope of acetabulum (tangential angle). With a smaller subluxation force (the value is not mentioned), the tangential angle is 18° , but with a larger subluxation force (the value is not mentioned), the slope angle is 40° .

By using Mitin's worked out skiagram, Plahotin, Belov and Mustakimov (1990) have stressed that a negative tangential angle meets the standard, while in pathological cases tangential angle is positive (the values of angles are not mentioned).

In our investigations, tangential angle in the left hip joint in Rottweiler breed dogs was from minus 30° to plus 48° with the average value $17.70^\circ \pm 3.61^\circ$, but in other breeds of dogs it was from minus 38° to plus 63° with average value $9.82^\circ \pm 6.20^\circ$. According to the results, in case of HD with a probability $P=97\%$ in Rottweiler breed dogs, tangential angle is larger in comparison with that in other breeds of dogs.

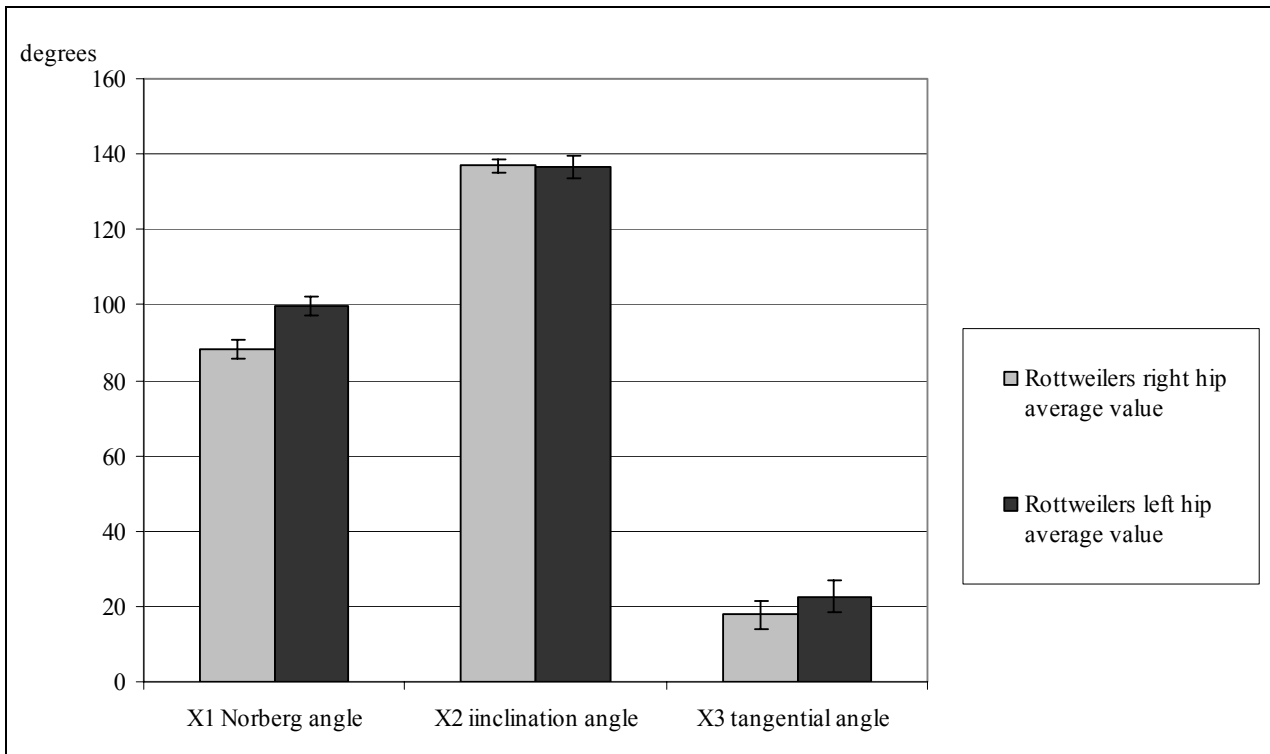


Figure 7. A graphical display of morphometrical parameters X1, X2, and X3 of the right and left hip joint in Rottweilers

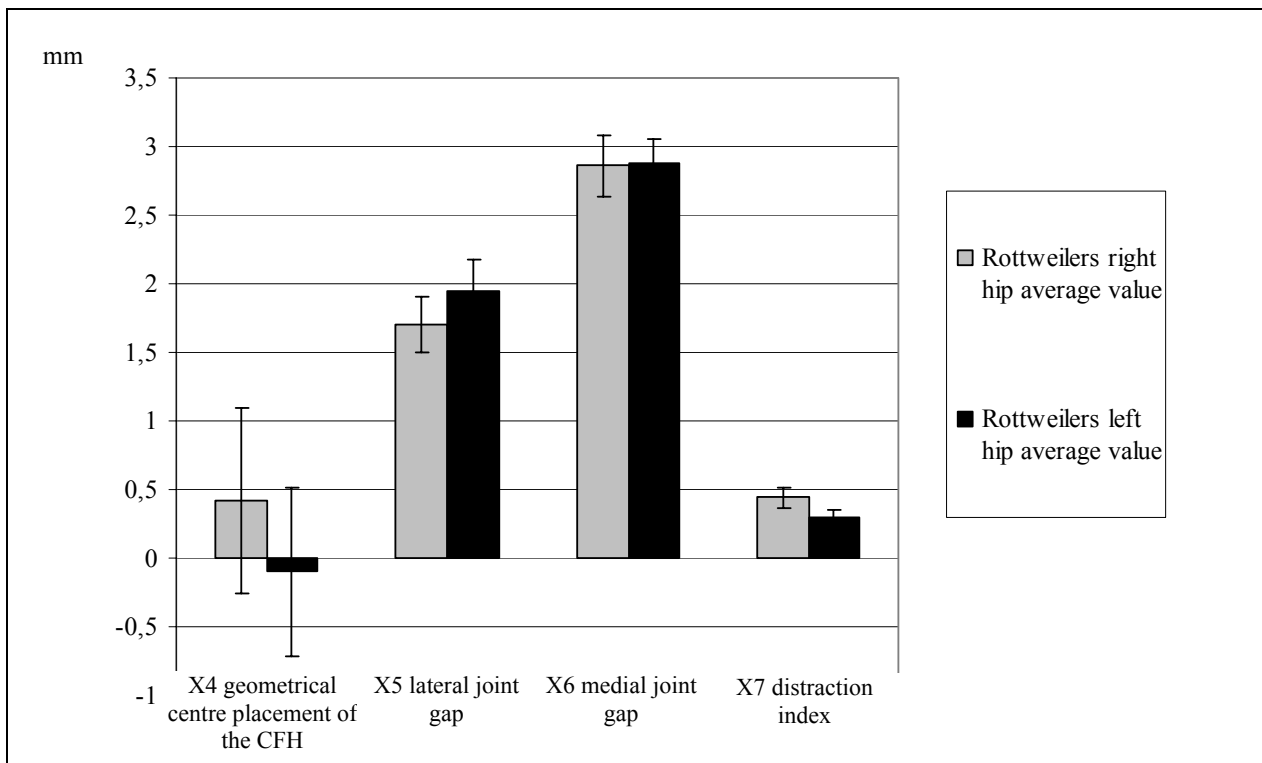


Figure 8. A graphical display of morphometrical parameters X4, X5, X6 and X7 of the right and left hip joint in Rottweilers

The width of medial joint gap (X6). Banfield et al. (1996) do not indicate to any correlation between the width of joint gaps and HD. In this study, the medial and

lateral joint gap is measured in millimeters in order to be able to carry out further calculations and data analysis. In Rottweiler breed dogs, medial joint gap of the left hip was

from 1 to 5.5 mm with the average value 2.86 ± 0.22 mm, but in other dog breeds the medial joint gap was 1.5 mm to 4.8 mm with the average value 3.06 ± 0.29 mm. The parameter KX6 (medial joint gap) with a probability

$P=99\%$, differs significantly in Rottweiler breed dogs compared with other breed dogs, i.e. the medial joint gap in Rottweilers is larger than in other breeds of dogs.

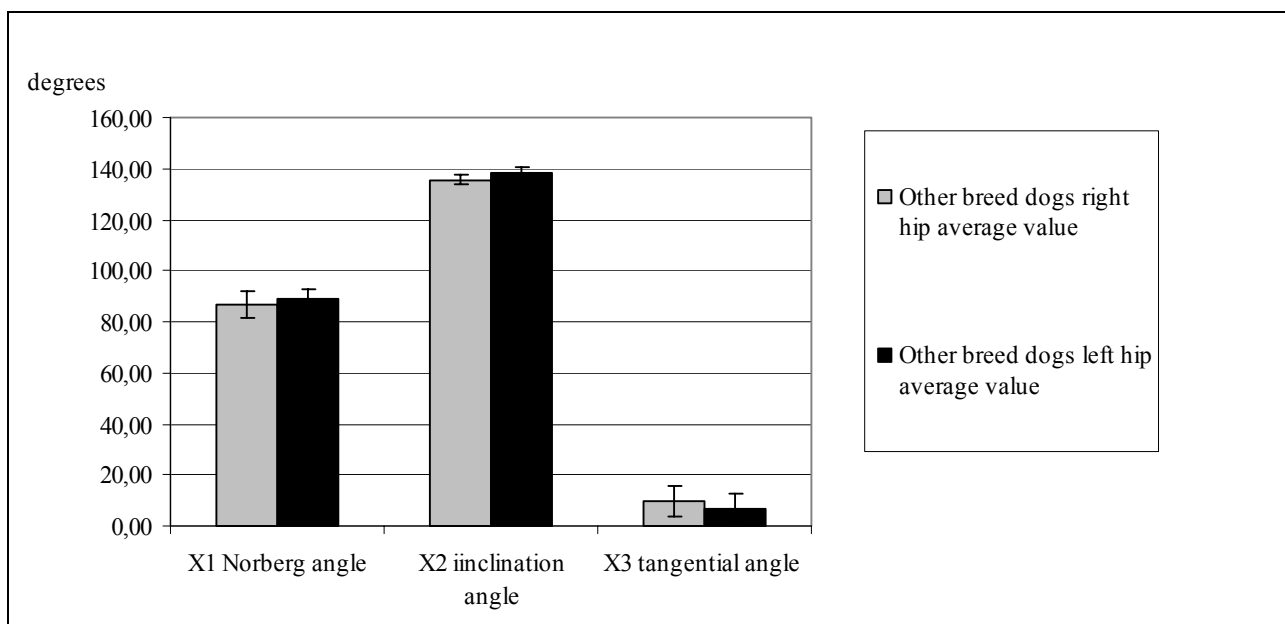


Figure 9. A graphical display of morphometrical parameters X1, X2, and X3 of the right and left hip joint in other dog breeds

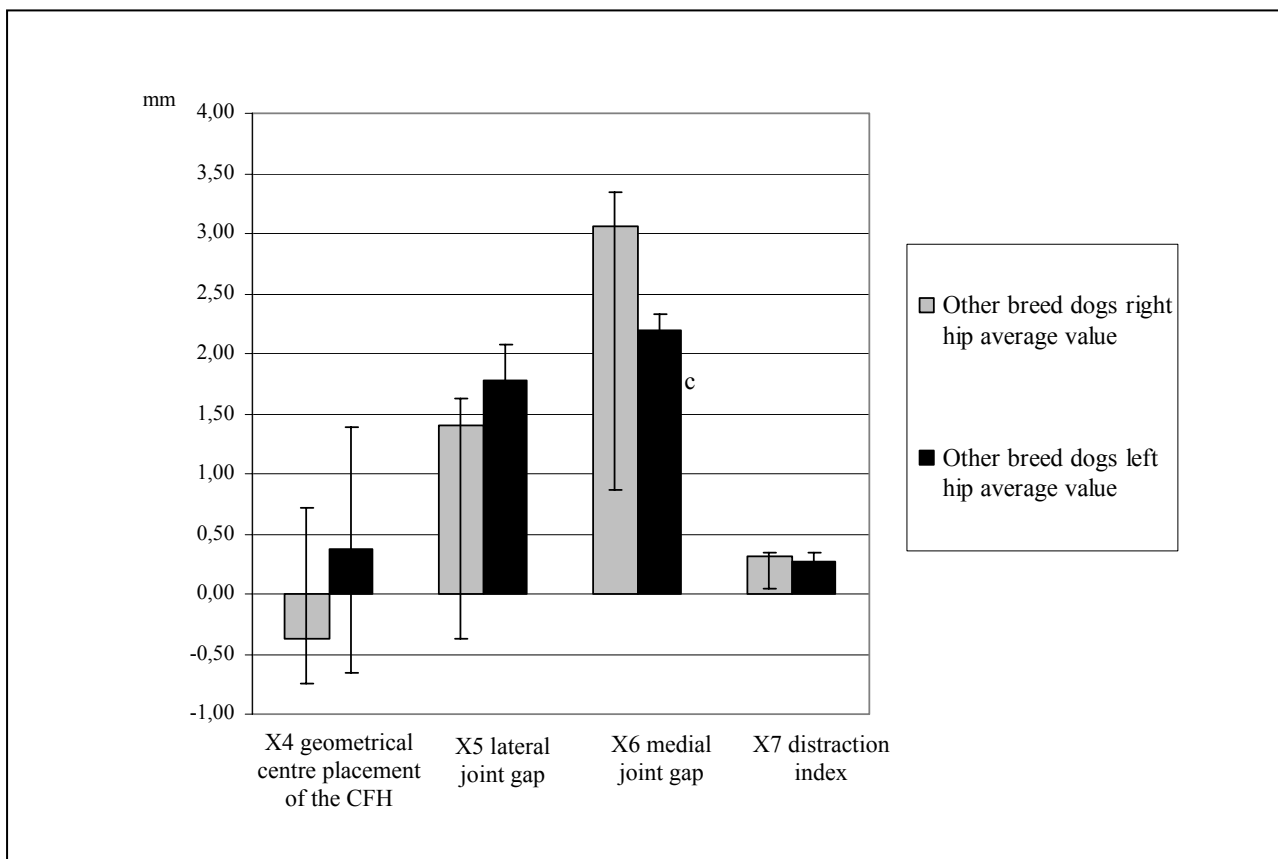


Figure 10. A graphical display of morphometrical parameters X4, X5, X6 and X7 of the right and left hip joint in other dog breeds

Distraction index (X7). Smith, Biery un Gregor (1990) are the first who introduce the use of distraction index (DI) method in veterinary literature. The applied index in the new method is fixed from 0 to 1, when 0 means a complete joint congruence, and 1 indicates to an extreme lax joint.

The permissible standard of distraction index or amount is 0.3. (Smith 1995 and 1997). According to Smith (1990), the recommended projection for distraction index calculation is dorsoventral position of the animal with hind legs perpendiculary lifted and laterally forced spread hip joints.

In this study, the formula to calculate the distraction index is the classical dorsoventral position.

In Rottweiler breed dogs, the distraction index is from 0.07 to 0.99 with the mean value 0.44 ± 0.07 , but in the other breeds of dogs it is from 0.08 to 0.56 with the mean value 0.31 ± 0.03 . Significant differences of the mentioned parameter (P value is smaller than 95%), however, are not established within a breed as well as mutually comparing it among breeds of dogs.

Conclusions.

1. In case of HD, tangential angle of the left hip joint (KX3) with a probability P=97% in Rottweiler breed dogs is larger if compared with other breeds of dogs.

2. In case of HD, the medial joint gap of the left hip joint (KX6) with a probability P=99% is larger than in other breeds of dogs.

3. In case of HD, comparing the right and left hip joint in other dog breeds, the medial joint gap of the right hip joint (LX6) with a probability P=94% is wider than the left hip joint medial joint gap (KX7).

4. In case of HD, the right hip joint distraction index (LX7) with a probability P=94%, that is close to significant, is more expressed than that in other breeds of dogs.

5. Comparing the mean distraction index parameters between the right and left hip joint (KX7 and LX7), it is obvious that with a probability P=93%, that is close to significant, the right hip joint distraction index in case of HD in Rottweiler breed dogs is larger than the left hip joint distraction index.

References

- Morgan J., Stephens M. Radiographic Diagnosis and Control of Canine Hip Dysplasia. Ames. Iowa State University press. 1988. P. 145.
- Powers M.Y., Biery D.N., Lawler D.F., Evans R., Shofer S., Mayhew P. Use of the caudolateral osteophyte as an early marker for future development of osteoarthritis associated with hip dysplasia in dogs. JAVMA. 2004. Vol. 225 (2), P. 233-237
- Белов А.Д., Данилов Е.П., Дукур И.И., Копѣнкин Е.П., Майоров А.И., Митин В.Н., Мустакимов Р.Г., Плахотин М.В., Пономарьков В.И., Филиппов Ю.И., Чижов В.А. Болезни собак. Справочник. Москва: Агропромиздат. 1990. стр. 207-210.
- Brass W., Paatsama S. Hip dysplasia - International Certificate and Evaluation of radiographs. Helsinki, 1983. P 25.
- Morgan J. The pathology of canine hip dysplasia. Canine hip dysplasia. The Veterinary clinics of North America. Small Animal practice. 1992. Vol. 2 (3). P. 541-551.
- Arhipova I., Bāliņa S. Statistika ekonomikā. Risinājumi ar SPSS un Microsoft Excel. Rīga: Datorzinību Centrs. 2003. lpp.

352.

- Christensen R. Analysis of variance. Design and Regression. Applied statistical methods. Published by Chapman & Hall. London. 1996. P. 587.
- Hauptman J., Cardinet G., Morgan J., Guffy I., Wallace L. Angles of inclination and anteversion in hip dysplasia in the dogs., AJVR. 1985. Vol. 46 (10). P. 2033-2036.
- Banfield C., Bartels J. A retrospective Study of Canine Hip Dysplasia in 116 Military Working Dogs. Journal of the American Animal Hospital Association. 1996. Vol. 32(5) P.413-430.
- Smith G., Biery D., Gregor T. New concepts of coxofemoral joint stability and the development of a clinical stress radiographic method for quantitating hip joint laxity in the dog. JAVMA. 1990. Vol. 196(1). P. 59-70.

Received 17 March 2008

Accepted 30 May 2008