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Inclination and Anteversion of *Collum Femoris* in Hip Dysplasia and Coxarthritis

By *J. S. Madsen* and *E. Svalastoga*

Department of Clinical Studies, Small Animal Hospital, Royal Veterinary and Agricultural University, Frederiksberg, Denmark.

Madsen, J. S. and E. Svalastoga: Inclination and anteversion of *collum femoris* in hip dysplasia and coxarthritis. Acta vet. scand. 1994, 35, 115-119. – Femoral neck angles were measured radiographically in 41 dogs examined for hip dysplasia. Steep femoral neck inclination was found to be a phenomenon of hip dysplasia and coxofemoral joint laxity. The altered biomechanics of a steep femoral neck inclination may be a factor in the pathogenesis of hip dysplasia and secondary osteoarthritis.

dogs; femoral neck; angles; osteoarthritis; pathogenesis.

Introduction

Increased femoral neck angles have been related to hip dysplasia *(Prieur* 1980, *Morgan & Stephens* 1985). On the basis of this observation the hypothesis was that increased stress caused by an abnormal femoral neck angle may be a significant factor in the pathogenesis of joint laxity, hip dysplasia and secondary osteoarthritis *(Prieur* 1980, *Arnoczky & Torzilli* 1981). However, other investigations show that age *(Dunlap & others* 1953, *Henriksson* 1980) and osteoarthritis *(Dueland* 1980, *Montavon & others* 1985) affect the angle.

The present study was designed to elucidate the significance of femoral neck angle on the biomechanical aspects of pathogenesis of hip dysplasia and osteoarthritis. Further, as joint laxity appears as an early phenomenon *(Riser & Shirer* 1966, *Henricson et al.* 1966), this factor was evaluated separately.

Materials and methods

The study comprised 41 medium to large sized dogs predisposed for hip dysplasia, representing different breeds as well as cross breeds (median weight 30.0 kg, range 15.4-70.0 kg) of a median age of 4.0 years (range 0.5-10 years). All dogs were anaesthetized prior to clinical examination. The Ortolani test for joint laxity was applied to 36 dogs. The dogs were grouped according to the coxofemoral joint with the highest degree of laxity. The pelvis and femora were radiographed with the dog in supine position using a standard method with extended hips *(Rendano & Ryan* 1985), and mediolateral exposure of each femur was added. In order to minimize the effect of interobserver variation reported elsewhere *(Hauptmann* 1983), the same person evaluated all the femoral neck angles in the present study. Measurement of femoral neck anteversion was made by the method described by *Schawalder & Sterchi* (1981), which enables correction of the femoral neck inclination for the actual anteversion. Mean femoral neck angles were calculated from the anteversion and inclination angle of both sides. The mean femoral neck angles were used to characterize each dog.

Hip dysplasia was evaluated radiographically by measurement of the Norberg angle. Only dogs in which the Norberg angles from both sides were at least 105 degrees were judged normal. All others were judged dysplastic.

In order to evaluate the influence of osteoarthritis on the femoral neck angles, the dogs were grouped according to whether osteoarthritis was present.

The influence of the age was evaluated; dogs under 2 years of age were compared to the older dogs.

Nonparametric statistical analysis, the Mann Whitney rank sum test for unpaired observations, was used to elucidate statistical association between the femoral neck angles, age, joint laxity, hip dysplasia and osteoarthritis.

For the purpose of comparing femoral neck angles 2 classes were defined, the borderline between the classes being the 75 percentile of the inclination angle of the non dysplastic dogs.

Results

All results are shown in tables 1, 2, 3 and 4. Tables 1 and 2 show that femoral neck inclination was statistically significantly greater in dogs showing hip dysplasia than in normal dogs ($p < 0.05$). Further, table 3 show that non osteoarthritic dogs with hip dysplasia had a significantly greater inclination angle than dogs without dysplasia ($p < 0.05$).

Femoral neck anteversion was significantly greater in dogs with a steep inclination angle than in dogs with a small inclination angle ($p = 0.004$, Table 1, 2).

In dogs with osteoarthritis the femoral neck angles were different from those of normal dogs, but the differences were not significant ($p = 0.1$); Table 1, 2). Evaluation of the femoral neck angles of dysplastic dogs showed that in these dogs the size of the angles was unrelated to osteoarthritis (Table 4).

Further, the present study showed that coxofemoral joint laxity was greater in dogs with dysplasia ($p = 0.02$; Table 1, 2) than in normal dogs.

A statistically significant association was shown between dysplasia and osteoarthritis ($p = 0.0001$; Table 1, 2).

Discussion

It appears from the present study that femoral neck inclination is significantly greater in dogs with hip dysplasia or coxofemoral joint laxity than in normal dogs ($p \leq 0.05$). Further, in non osteoarthritic dogs, those with hip dysplasia had significantly greater inclination angles ($p = 0.04$), and those with coxofemoral joint laxity had non significantly greater inclination angles than normal dogs ($p = 0.06$). A relationship between femoral neck anteversion and hip dysplasia or osteoarthritis was not shown in this study, but anteversion angles were significantly greater in dogs with a steep inclination angle than in dogs with a small inclination angle ($p = 0.004$). Furthermore, a relationship between dysplasia and joint laxity and between dysplasia and osteoarthritis was demonstrated.

The present study supports the work of *(Prieur* 1980, *Morgan & Stephens* 1985) showing an increased femoral neck inclination in dogs with hip dysplasia. However, our results are in contrast to the study of *Hauptmann et al.* (1985), where a decrease in femoral neck inclination was demonstrated in dogs with hip dysplasia.

In the literature, increased femoral neck anteversion has been claimed to be associated with hip dysplasia in dogs *(Prieur* 1980, *Morgan & Stephens* 1985); but only few studies have actually measured the neck angles thoroughly and compared sound and dysplastic hips *(Riser & Shirer* 1966, *Dueland* 1980, *Hauptman et al.* 1985). *Dueland* (1980) re-

Table 1. Data concerning the relationship between hip dysplasia, coxofemoral joint laxity, osteoarthritis, age and the femoral neck angles of 41 dogs. As only 36 dogs were tested for joint laxity all data concerning joint laxity are shown in parantheses.

	Number of dogs	Dysplasia		Joint laxity		Osteoarthritis		Inclination*	Anteversion*
		yes	no	yes	no	yes	no		
Dysplasia									
yes	28							148.0° 142.0°-151.5°	36.8° 31.0-42.5°
no	13							142.0° 140.5°-145.0°	32.5° 31.0°-33.5°
Joint laxity									
yes	(18)	(15)	(3)					(147.5°) (142.5°-152.5°)	(34.5°) (32.5°-43.0°)
no	(18)	(8)	(10)					(142.3°) (139.0°-148.0°)	(34.0°) (31.0°-39.5°)
Osteoarthritis									
yes	18(15)	18	0	(9)	(6)			149.0° 141.5°-152.5°	38.3° 32.0°-43.0°
no	23(21)	10	13	(9)	(12)			143.0° 140.5°-148.0°	32.5° 30.0°-37.0°
Age									
>2 years	31(26)	22	9	(11)	(15)	16	15	147.0° 140.5°-150.5°	35.0° 30.5°-41.5°
≤2 years	10(10)	6	4	(7)	(3)	2	8	144.0° 142.0°-151.0°	32.8° 31.5°-38.0°
Inclination									
>145.0°	21								38.5° 33.5°-43.0°
≤145.0°	20								32.3° 29.8°-34.0°

* Medians, 25(Q1) and 75(Q3) percentiles of the femoral neck angles are shown.

Table 2. Relationship between hip dysplasia, joint laxity, osteoarthritis, age and the femoral neck angles. The table shows the probabilities of the Mann Whitney test under the null-hypothesis, that differences between the classes occur by chance.

	Dysplasia	Laxity	Osteoarthritis	Age	Inclination
Joint Laxity	0.02				
Osteoarthritis	0.0001	0.33			
Age	0.5	0.15	0.09		
Inclination	0.02	0.05	0.1	0.8	
Anteversion	0.1	0.52	0.1	0.9	0.004

Table 3. Relationships between femoral neck angles (variables) and hip dysplasia (classes) and between femoral neck angles (variables) and joint laxity (classes) of 23 non osteoarthritic dogs. (Two dogs were not tested for joint laxity). Medians, 25(Q1) and 75(Q3) percentiles of the femoral neck angles are shown. The table shows the probabilities of the Mann Whitney test under the null-hypothesis, that there are no differences between the classes.

	N	Inclination	Anteversion
Dysplasia			
yes	10	147.5° (142.5°-151.0°)	32.5° (31 0°-33.5°)
no	13	142.0° (140 5°-145.0°)	34 0° (29.5°-42.0°)
Joint laxity			
yes	12	144.5° (142.0°-150.0°)	33 5° (32.5°-38.0°)
no	9	141.0° (138.5°-146.0°)	31.3° (29.8°-34 5°)
$P_{dysplasia-osteoarthritis}$		0.04	0.7
$P_{joint\ laxity-osteoarthritis}$		0.06	0 2

Table 4. Relationshhip between femoral neck angles (variables) and osteoarthritic (classes) of 28 dysplastic dogs. The table shows the probabilities of the Mann Whitney test under the null-hypothesis, that there are no differences between the classes. Medians, 25(Q1) and 75(Q3) percentiles of the femoral neck angles are shown.

	N	Inclination	Anteversion
Osteoaarthritis			
yes	18	149.0° (141.5°-152 5°)	38.3° (32.0°-43.0°)
no	10	147.5° (142.5°-151.0°)	34.0° (29.5°-42.0°)
$P_{Osteoarthritis+dysplastic}$		0.7	0.4

ported that the anteversion angle was significantly increased in dysplastic dogs, and he also found that the femoral neck anteversion increased significantly when hip dysplasia was complicated with osteoarthritis. The paper of *Montavon et al.* (1985) tend to support the latter observations. Contrary, *Hauptman et al.* (1966) and the present paper failed to find a relationship between hip dysplasia or osteoarthritis and the anteversion angle.

Age did not affect the femoral neck angles in the present study. This is in accordance with previous reports that femoral neck angles show only minor changes from birth to maturity *(Riser & Shirer* 1966, *Hauptman & Butler* 1980). Contrary, in humans the ontogenetic changes are considerable *(Dunlap et al.* 1953, *Henriksson* 1980).

Different methods of measuring the femoral neck angles is reflected in the variation of normal angle size (130°–145°) reported *(Hauptman et al.* 1979, *Hauptman & Butler* 1980, *Hauptman* 1983, *Hauptman et al.* 1985, *Montavon et al.* 1985, *Schawalder & Sterchi* 1981). In the present study, the method described by *Schawalder & Sterchi* (1981) was chosen, and the femoral neck inclination was accordingly corrected for the actual anteversion. The biplanar technique is easy to perform and has the same accuracy as direct measurement of the femoral neck anteversion angle using a single radiograph with the femoral shaft in cross section *(Nunamaker et al.* 1973, *Bardet et al.* 1983). In addition, the biplanar technique correlates well with direct measurement on bone *(Bardet et al.* 1983, *Montavon et al.* 1985).

In the present study there is an increased femoral neck inclination in dogs with joint laxity, hip dysplasia and osteoarthritis. The difference between normal dogs and dogs with hip dysplasia or joint laxity is significant. This study, therefore supports the hypothesis that a steep femoral neck inclination will stress the hip joint because of increased vertical forces and thus predispose the joint to secondary changes *(Prieur* 1980, *Arnoczky & Torzilli*

1981, *Bombelli* 1983). Whether an increased femoral neck inclination is a primary condition or a consequence of hip dysplasia is not elucidated in this study. The material investigated precludes conclusions as to the breed significanse of the reported observations. However, we find it interesting that an increased frequency of femoral neck inclinations is observed in non osteoarthritic dogs with hip dysplasia. Thus, a primary role of increased femoral neck inclination is possible in the pathogenesis of hip dysplasia in dogs.

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Sammendrag

Inklinations- og anteversionsvinkler på collum femoris hos hunde med hofteledsdysplasi og osteoarthritis

Anteversions- og inklinationsvinkel for collum femoris blev bestemt ved radiologisk undersøgelse af 41 store og mellemstore hunde. Ved samme undersøgelse blev alle hundene undersøgt for hofteledsdysplasi.

Inklinationsvinklen var statistisk signifikant større hos hunde med hofteledsdysplasi og hos hunde med hofteledsinstabilitet end hos kontrolhunde.

Undersøgelsen støtter således hypotesen, at en forøget inklinationsvinkel og den dermed ændrede biomekanik kan være af betydning for udvikling af hofteledsdysplasi hos hund.

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Reprints may be requested from: J. S. Madsen, Department of Clinical Studies, Small Animal Hospital, Royal Veterinary and Agricultural University, Bülowsvej 13, DK-1870 Frederiksberg C, Denmark.