Hip Dysplasia: Coxafemoral Abnormalities in Neonatal German Shepherd Dogs

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Abstract—1. Hip dysplasia in German Shepherd Dogs, half of which could be expected to develop detectable hip dysplasia by 1 yr of age, was not observed at birth. This was based on the dissection and gross examination of the pelves of eighty-seven neonatal pups. Minor ligamentous changes which may suggest beginning hip dysplasia were seen in three pelves from pups 30 days old.

2. The round ligament seems to serve to stabilize the hip joint at birth. This function appears to be lessened and even discontinued when the ligaments lengthen after the first 3–4 months of life.

3. It is suggested that the presence of a "frayed" round ligament may be the result of hip joint instability and undue stress on associated tissues.

4. The rotation angle of the femoral neck on the femur was found to be 0° in most cases. Occasionally an anteversion of 5°, and rarely 10°, was seen. It is believed that the degree of anteversion has little significance as a cause of hip dysplasia in the dog.

INTRODUCTION

Hip dysplasia is one of the oldest recognized skeletal diseases. The cause is still unknown and it is not clear when and how an individual first becomes affected.

In an attempt to determine when the earliest gross changes appear, a large number of pelves of neonatal pups from affected German Shepherd Dog stock were examined. Lesions associated with and characteristic of hip dysplasia were not recognized in any of the pups which ranged in age from birth to 10 days. Changes observed in the round ligaments of pups 30 days old may have been associated with the beginning of hip dysplasia.

MATERIALS AND METHODS

The pelves were from eighty-seven young pups, ranging in age from birth to 1 month. Seventy-nine pups were purebred German Shepherd Dogs and one litter of eight pups was from a Golden Retriever sire and a German Shepherd Dog dam. The specimens came from three German Shepherd Dog breeding kennels and the

*From the School of Veterinary Medicine, University of Pennsylvania, Philadelphia. This investigation was supported by the U.S. Public Health Service, Research Grant HD 00442 from the National Institute of Child Health and Human Development. Acknowledgement is also made to veterinarians, dog breeders, and kennel clubs for their assistance and support.
parent stock was known to have an incidence of hip dysplasia exceeding 50 per cent. The pups were dead and the carcasses fixed in 10 per cent formalin when received. They were not identified as to litter, parents, sex, or specific age in days. Ten pups had been either still-born or crushed to death by their mothers shortly after birth. The remainder had been euthanized.

The pelvis and femurs when dissected were separated from the rest of the body. The joint capsules were opened and the pelvis, femurs, joint cavities, articular surfaces and round ligaments were observed for abnormalities with the aid of a magnifying dissecting lens and lamp. To estimate the degree of the femoral head rotation, the femurs were disjoined and the condyles of the distal end layed caudal side down on a horizontal surface. The femoral head was raised by supporting it on a glass slide standing on edge with the long side in a horizontal plane. The rotation angle of the femoral head and neck was estimated with the aid of a protractor by looking down the femoral shaft. The length of the femurs was measured from the farthest point distally and proximally viewed from the lateral side. The rotation angle of the femoral necks and the length of the femurs were measured on fifty-five pelves.

OBSERVATIONS

The first observations made on thirty-two pelves from pure-bred German Shepherd Dog pups ranging in age from birth to 10 days revealed no gross abnormalities in shape of pelvis, acetabulums, femurs, and femoral necks and heads. However, no record was made of the comparative lengths of the round ligaments and the rotation angle of the femoral neck and head.

Since this method revealed no abnormalities in the first group of pelves examined, differences in the comparative length of the round ligaments and the rotation angle of the femoral neck in the remaining lot of fifty-five specimens were evaluated. Forty-seven of these were from purebred German Shepherd Dog stock and eight were from a German Shepherd Dog-Golden Retriever cross. The ages ranged from birth to 30 days.

The fifty-five specimens were divided into three age groups according to femur length. Measurements from a group of serial radiographs determined the range:

Group 1—thirty-eight pelves from pups aged 0-10 days. These femurs were 4 cm or under in length. Group 2—seven pelves from pups aged 2-3 weeks. These femurs were 4.2-5.0 cm in length. Group 3—ten pelves from pups aged 1 month. These femurs were 5.2-6.0 cm in length.

Group 1. Thirty-six pelves were normal in appearance and shape. In two pelves, one hip joint of each was abnormally developed. In one, half of the pelvis, the acetabulum, the femoral head, and the diameter of the shaft of the femur were one-third smaller than the contralateral member. In the other pelvis, the contour of one acetabulum was irregular in shape. The femoral head and femur on that side were normal in appearance. In the thirty-six normal-appearing pelves, the ligaments of twenty-nine pelves were short and held the femoral heads tightly in the acetabulums. The ligaments of six pelves were longer, and were designated as medium in length. This means that when the capsule was opened, the femoral head could be subluxated for a distance of about 1 mm. In one of the six pairs, the ligament on one
head was short and the other one was medium in length. In the remaining pelvis the ligaments were classified as long, which means that these ligaments were long enough to allow the foveae to extend laterally to the edge of the rims of the acetabulums. The heads also fit loosely in the acetabulums.

**Group 2.** The seven pelves were normal in appearance and shape. Four had ligaments that were classified as short. In one pelvis, one ligament was short and one medium in length and on two pelves the ligaments were of medium length.

**Group 3.** The ten pelves were normal in appearance and shape. The ligaments of four pelves were short, and in two pelves the ligaments were short on one side and medium on the other side. In four pelves all the ligaments were of medium-length. In three of the latter, the six ligaments were medium-length, but in addition they were “frayed.” The term “frayed” means that some of the fibers at the periphery of the ligaments were torn. In addition, they were hemorrhagic and a small amount of whitish flocculent material was found in the joint cavity.

The rotation angle of the femoral neck was recorded on the femurs of fifty-five pelves.

**Group 1.** In the thirty-eight pups less than 10 days old, the range was estimated from 0° for sixty-five femurs (which is a true right angle to the shaft) to 5° anteversion for eleven femurs.

**Group 2.** The femoral rotation angle for the seven pelves of the 2–3 wk old group was 0° for ten femurs and 5° anteversion was estimated for three femurs. One femoral neck and head had a slight retroversion tilt.

**Group 3.** Of the ten specimens 4 wk old, thirteen femurs had 0° anteversion, three femurs were estimated at 5° anteversion, and four femurs in two pelves were estimated at 10° anteversion.

**DISCUSSION**

Well documented studies in dogs on when and how hip dysplasia appears have not been reported. The dogs from which these pelves were taken, if they had lived to maturity, could be predicted to have had at least a 50 per cent incidence of hip dysplasia because of their known breeding.

In dysplastic children, it is fairly well documented that anatomical changes are rarely, if ever, present at birth. Hip joint instability and the Ortoloni click are present (Rosen, 1962). I have observed and demonstrated this click in a few children shortly after birth.

In this sampling of pups, there was no evidence of instability at birth and the round ligaments were so short that the attachments fractured away from the femoral head when subluxation was forced. The Ortoloni click cannot be demonstrated in pups until some weeks after birth, by which time radiographic signs of subluxation are present.

Radiographically, the first anatomical changes in these cases that develop well-defined hip dysplasia usually appear quite dramatically and consistently between the 12th–18th wk. In the mild cases, the radiographic changes manifest themselves slowly and are not recognized until the dog is 6 months old (Whittington et al., 1961). In a few instances, a dog may be 1 yr old before an opinion can be rendered on whether hip dysplasia is present. In German Shepherd Dog pups the earliest well-defined radiological dysplastic changes we have seen were at 8 wk.
Dysplastic changes in the cartilage and bones of dogs are thought to occur earlier than in children in terms of time with respect to days and weeks of age; therefore, it was thought that hip joint instability or acetabular "shallowness" might be detectable in some pups at birth.

One possible explanation of hip joint instability and the Ortoloni click at birth in the child and not the pup, may be the postural differences and influences of utero-stress on the two fetuses. In the child in utero, the legs, which act as long levers, are extended the last few months of pregnancy and any pull or rotation placed on the legs has the effect of pulling the femoral head out and away from the hip joint. This would tend to lengthen and stretch all the supporting tissues of the hip joints. In the pup, the legs are short and are held in a flexed position and the joints are not subjected to subluxating stress prenatally. The first such stress experienced by the pup is associated with the effort of holding itself in position for nursing.

The original lot of specimens examined consisted of thirty-two pelves from pups ranging in age from birth to 10 days. When no abnormalities in appearance, shape or instability between the femoral head and acetabulum were detected this created discussion. It was noted that even though all the hip joints appeared normal and stable a few of the round ligaments were slightly longer than the others. In those joints with short ligaments, it was impossible to subluxate the femoral head even slightly without fracturing the cartilage of the femoral heads just lateral to the foveas.

Since no lesions associated with dysplasia were recognized in the joints of the original thirty-two pelves, it was then decided to estimate the length of the ligaments and the angle of rotation of the femoral heads in the next group examined. In human medicine, several investigations have described the angle of rotation of the femoral neck and the femur as a prime factor in hip dysplasia (Badgley, 1949; Wilkinson, 1962).

In the remaining 55 pelves examined, Group 1 consisted of thirty-eight pelves from dogs ranging in age from birth to 10 days. Two pups had unilateral malformed joints and both had either been stillborn or died shortly after birth. The cause of death was not determined, but the circumstances suggested that these pups at birth were weaker than normal and they may have represented some type of congenital malformation, a common cause of stillborn or neonatal death. Neither hip malformation was characteristic of hip dysplasia and therefore, probably not related to that disease. Furthermore, hip dysplasia is bilateral in approximately 93 per cent of the instances, and in these two cases, the abnormality was unilateral (Riser, 1963).

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The length of round ligaments in thirty-one of the thirty-six apparently normal pelves of Group 1 were short and allowed for no subluxation of the femoral heads. In the remaining five pairs, the ligaments were longer in length and allowed for a 1 mm lateral subluxation of the femoral head. One of these five pairs had extra long ligaments and the femoral heads fit loosely in the acetabulums.

The ligaments at birth in the normal pup appear to be short and are probably a means by which the heads are stabilized within the acetabulums. With age, and as the muscles of the pelvis develop full tone and function, the ligaments lengthen.

In Group 2, which consisted of seven specimens 10 days–5 wk of age, four pelves had short and three had medium length ligaments. Although the group was small,
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this showed a tendency for the ligaments to lengthen soon after birth (three in seven) as compared to thirty-one pairs of short and five pairs of medium length ligaments in the group from birth to ten days of age.

In Group 3 which consisted of ten pelves from the older animals, four pairs of ligaments were of medium length and three of the four pairs of ligaments were “frayed,” and the joint cavities contained coagulated flocculent material.

The function of the round ligaments is not well understood. At an early age when the ligaments are very short, they undoubtedly serve to control and stabilize the movement and position of the femoral heads at all times during hip movements. However, by 10—14 days of age, the ligaments lengthen and they no longer secure the femoral heads, as for example, the cruciate ligaments secure the stifle. It has been suggested that a major function of the ligament after it lengthens may be to assist with maintenance of a lubricant film between the rounded femoral head and the inverted acetabulum cup which rests upon it. Since fluid tends to run down and away from the bearing surfaces, there is little provision for the redistribution of synovial fluid to these surfaces unless it is the round ligament (Barnett et al., 1961).

Anteversion rotation of the femoral neck on the shaft of the femur has been discussed by a number of investigators as the cause of hip dysplasia (3-4). The rotation angle of eighty-eight of the 110 femurs from fifty-five animals was 0°; 5° for seventeen; and in four instances, it was 10° anteversion. One femoral neck showed a slight retroversion. The rotation angle, being 0° in most instances, seems insignificant as a pathogenetic factor of canine hip dysplasia.

The fact that one pelvis was found in which there were long ligaments and loose fitting hip joints might indicate a predisposing lesion of hip dysplasia, and these same changes in other hip joints might be expected to occur a little later.

The finding of six “frayed” ligaments out of twenty in the month-old group was unexpected. In addition to the “frayed” ligaments, coagulated material was found in the joint cavity. No other dysplastic changes were detected at this early stage. The “fraying” of ligaments is a common finding in early dysplasia in the age group of 12-20 weeks. Radiographically, we have been able to detect subluxation of the femoral heads before dysplastic lesions can be detected either histologically or macroscopically.

It is assumed that at least half of the dogs examined in the experiment, if allowed to live, would have been dysplastic. This is evidence that no gross lesions diagnostic of hip dysplasia are present at birth.

REFERENCES


Résumé—1. La dysplasie chez les chiens bergers allemands la moitié desquels peuvent développer une dysplasie de la hanche décelable à l'âge d'un an, n'est pas remarquée à la naissance. Ce rapport est basé sur la dissection et l'examen macroscopique du bassin de quatre vingts sept petits chiens nouveaux-nés. Alterations ligamenteuses mineures qui peuvent suggérer un commencement de dysplasie de la hanche ont été remarquées dans trois bassins de petits chiens âgés de 30 jours.

2. Le ligament rond paraît servir à la stabilisation de l'articulation de la hanche. Cette fonction paraît s'amoindrir et même disparaître quand les ligaments s'allongent après les premiers 3–4 mois.

3. Il est supposé que la présence d'un ligament rond ir régulier peut être la conséquence d'une instabilité de l'articulation de la hanche et d'une tension exagérée sur les tissus environnants.

4. L'angle de rotation du col fémoral sur le fémur a été trouvé d'être de 0 ; dans la majorité des cas. Occasionnellement une antéversion de 5° et rarement de 10° a été remarquée. On suppose que le degré d'antéversion a peu de signification comme cause de dysplasie de la hanche chez le chien.


2. Scheinbar dient das ligamentum teres bei der Geburt zur Stabilisierung des Hüftgelenkes. Diese Funktion scheint nach den ersten drei bis vier Monaten, in welchen sich das Band verlängert, nachzulassen oder sogar ganz aufzuhören.

3. Man nimmt an, dass ein ausgefasertes ligamentum teres das Resultat einer Hüftgelenksinstabilität und übergrosser Beanspruchung der angegliederten Gewebe sein könnte.