Acta vet. scand. 1995, *36*, 41-53.

Osteochondrosis in Wild Boar – Swedish Yorkshire Crossbred Pigs (F2 Generation)

By *H. Uhlhorn*[1], *G. Dalin*[1], *N. Lundeheim*[2], and *S. Ekman*[3]

[1]Department of Anatomy and Histology, [2]Department of Animal Breeding and Genetics, and [3]Department of Pathology, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Uhlhorn, H., G. Dalin, N. Lundeheim and S. Ekman: Osteochondrosis in wild boar – Swedish Yorkshire crossbred pigs (F2 generation). Acta vet. scand. 1995, 36, 41-53. – Osteochondrotic lesions occur in very high frequency in growing pigs of all commercial breeds and are claimed to be associated with high growth rate, and not to occur, or to be milder, in slow-growing pigs. The present study monitored the magnitude and distribution of osteochondrotic lesions in a crossbred pig population of wild boar and Swedish Yorkshire ancestry. In this population, having a low growth rate, the distribution and extent of osteochondrotic lesions was similar to that of purebred Swedish Yorkshire pigs, and only weak relationships between the studied growth parameters and osteochondrosis could be found.

growth rate.

Introduction

Osteochondrosis, or dyschondroplasia, is a generalized disease of growth cartilage. It is defined as a focal disturbance of endochondral bone formation causing retention of cartilage into the subchondral bone *(Olsson* 1978a). Osteochondrotic lesions have been shown to occur in the majority of growing pigs of the major breeds *(Nakano et al.* 1987). Ensuing secondary arthrosis and bone deformities will lead to lameness and gait disturbances and economic loss from the culling of breeding pigs *(Hill* 1990).

A relationship between osteochondrosis and rapid growth has been suggested and also that the disease does not occur, or is milder, in slow-growing pigs like the Yucatan pig *(Farnum* 1984) and wild boars *(Klaessen* 1987). Osteochondrosis has been reported in wild boar-domestic sow crossbred pigs, but the data on the prevalence are contradictory. *Reiland* (1978a) found no sign of osteochondrosis in crossbred pigs of wild boar heritage, while *Vogel* (1976) found the same amount of lesions in the medial femoral condyles of crossbred pigs as in purebred landrace pigs of the same weight.

The purpose of this study was to determine the magnitude and distribution of osteochondrotic lesions in a genetically heterogenous population of crossbred European wild boar – Yorkshire pigs of the F2 generation (W/Y pigs), and to study the correlation between osteochondrosis and certain growth parameters. The investigation was conducted as a part of a gene mapping project *(Andersson et al.* 1994).

Material and methods

One hundred and ninety five second generation (F2 generation) crossbred European Wild Boar and Swedish Yorkshire pigs (W/Y pigs), 107 castrates and 88 gilts, were examined. The

Table 1. Criteria for scoring of the medial condyles of the femur and the humerus *(Reiland et al.* 1978c).

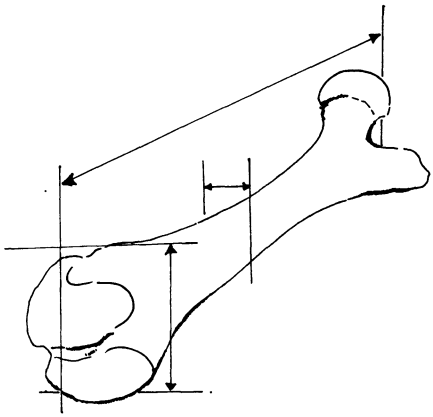
Score	Joint surface	Cartilage and subchondral bone on cut surfaces
0	Smooth and rounded	Normal thickness of cartilage and regular transition cartilage–bone
1	Smooth and rounded	Slight retention of cartilage
2	Flattened	Moderate retention of cartilage
3	Deformed	Large retention of cartilage
4	Deformed with crater formation	Large retention of cartilage
5	Deformed with dissecting lesion in cartilage	Dissecting lesion in retained cartilage

population was created by mating 2 wild boars to 8 Yorkshire sows. One boar and 10 gilts from the progeny of each wild boar (F1 generation) were selected as parents to the next generation. The F1 gilts were mated to a F1 boar of the other family producing 2 litters each.
The pigs, raised by a private breeder, were brought to the research station Funbo-Lövsta, Uppsala, in 2 batches at a mean age of 96 days (SD = 13) and a mean weight of 20.1 kg (SD = 3.7). The pigs of the first batch (n = 88) were about a week older (mean age 100 days, SD = 11), but of the same weight as the pigs of the second batch (n = 107) (mean age 94 days, SD = 14). The littermates of each batch were split into 2 groups with different feeding regimes.
Comparisons were also made with 942 purebred Yorkshire pigs from the Swedish progeny testing scheme for 1990-1991, being slaughter evaluated at the same laboratory in Uppsala as the W/Y pigs. Compared to the W/Y population, the 471 castrates and 471 gilts of the testing scheme were brought up under almost the same housing and management conditions but had higher weight at slaughter (104 vs 84 kgs), lower age at slaughter (181 vs 213 days), and higher feeding intensities (weight scales: maximum 3.4 kgs/day vs 2.75 kgs/day).

Housing
The pigs were kept in an ordinary hogstable. Castrates and gilts were kept in separate pens, 5 animals in each, with concrete floor and straw bedding.

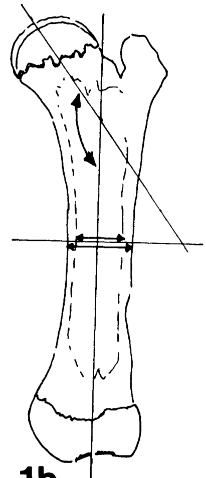
Feeding
The first batch of pigs was used in a study comparing 2 feeding intensities and the pigs of the second batch for evaluating the effects of different lycine levels.
The first batch was divided into 2 groups (n = 39 and 49, respectively). Both groups were fed a standard hog feed containing 16% crude protein, 0.85% lycine and 12.2 MJ/kg. The first group (N70) was fed a decreased ration of 70% of the Standard Swedish Norm (SLU–norm), *(Andersson* 1984), and the second group (N90) was fed 90% of the SLU–norm.
The second batch was also divided into 2 groups (n = 53 and 54, respectively). Both groups were fed 90% of the SLU-norm, but the feed of the first group (L75) had a reduced lycine content (0.75%) compared to the second group (L85) (0.85%). Thus groups N90 and L85 were fed according to the same ratio.

Clinical registrations
Four pigs out of the population of 195 showed



1a

Figure 1a. Left femur. Measuring points for length, width at diaphysis and at epiphysis are indicated.



1b

Figure 1b. Left femur, cut along the plane of the longitudinal axes of the diaphysis and the collum femoris. The angle between the 2 axes, i.e. collum angle and the measuring points for cortical thickness are indicated.

signs of lameness or gait disturbance during the experiment. One case was due to an infected hoof, and the 3 others were diagnosed as arthritis of possible infectious origin, since the symptoms disappeared after a few days of treatment with antibiotics.

Sample collection

The pigs were killed by exsanguination after electrical stunning. The femur, humerus and radius/ulna from the left side were removed for measurements of length, width at the diaphysis, width at the epiphysis, angle between the axis of the collum femoris and the axis of the diaphysis, cortical thickness, and macroscopical osteochondrosis examination. The distal femur, humerus, ulna, and the costochondral junctions of the fifth, sixth, and seventh ribs from the right side were removed and fixed in 70% alcohol for radiological and histological osteochondrosis evaluation.

Gross examination

The left femur and humerus were stripped of muscle and examined for lesions of osteochondrosis according to the routines of the Swedish pig progeny testing scheme. All pigs in this testing are scored for the presence and severity of joint lesions due to osteochondrosis in the medial femoral condyle and in the medial humeral condyle. These scores range from 0 (best) to 5 (worst), according to *Reiland et al.* (1978b) (Table 1).

Bone measurements

The weight and a number of size parameters for the left femur were recorded: length, width at diaphysis, and width at epiphysis. Thereafter the femur was cut along the plane of the longitudinal axes of the collum femoris and the diaphysis. The thickness of the cortex was measured at the middle of the diaphysis. The bone contour was transferred to plastic film at 2 independent occasions, and the angle between the axes of the collum femoris and the diaphysis was measured. The mean of the 2 angle measurements was termed "collum angle", see Fig. 1a and 1b.

Radiological examination

Serial sections, 5-7 mm thick, through the distal femur and humerus of the right side, were cut in a plane at right angles to the middle third of the articular surface, the section shown to have the highest prevalence of osteochondrotic lesions *(Reiland* 1978b, *Carlsson et al.* 1988). Each section included the articular-epiphyseal cartilage complex, epiphysis, metaphyseal growth cartilage, and a portion of the metaphysis. The metaphyseal cartilage predilection sites, i.e., the distal ulna and costochondral junctions *(Reiland* 1978b), were cut in 5 mm thick sagittal sections.

The sections were radiographed on envelope wrapped Kodalith Ortho type 3 film. The radiological examination was made with a custom built roentgen apparatus with a Machlett AEG 50A tube with a 1.5 mm×1.5 mm tungsten target and a 1.0 mm thick beryllium window. Exposure data were 25 kV, 18 mA, F.f.d. 60 cm, time 5-15 min.

Radiographs were examined on a light table without prior knowledge of treatment group and were assigned to 4 categories according to the extent of the radiolucent areas in the subchondral bone;

0 = no changes
1 = radiolucent area < 2 mm (width or depth)
2 = multiple changes according to 1. or single 2-5 mm (width or depth)
3 = multiple changes according to 2. or single or multiple > 5 mm (width or depth).

Doubtful cases were cut into thinner sections and reradiographed.

Histologic verification of radiological findings

For histologic verification, randomly selected sections were taken from 20% of the sites with radiological findings. Samples selected for histologic examination were decalcified in 15% formic acid with sodium formiate, dehydrated in graded alcohols, embedded in paraffin, cut into 6 μm thick sections, and stained with hematoxylin and eosin for light microscopy.

Statistical analysis

Data from the examination of bones and articular surfaces were analysed statistically together with the following growth parameters: weight at slaughter, age at slaughter, daily weight gain from birth to the start of the experiment, daily weight gain during the experiment, and daily weight gain for the entire period from birth to slaughter. Complete growth data were available for all 195 pigs. Macroscopical osteochondrosis data for the left medial femoral and humeral condyles were obtained from 192 and 190 pigs respectively. From the limbs of the right side, radiological osteochondrosis data were obtained from 188 pigs from the lateral and medial condyles of the humerus and from the lateral condyle of the femur and from 187 pigs from the medial femoral condyle. Complete bone measurements from the left femur were obtained for 171 pigs.

Analysis of variance was carried out with the Statistical Analysis System *(SAS Institute Inc.* 1985). The model for analysis of variance included the effects of: sex, treatment group, interaction between sex and treatment group. Residual correlations between the analysed traits were calculated.

Levels of significance are expressed conventionally: ns = not significant ($p>0.05$),

* = $p\leq0.05$, ** = $p\leq0.01$, and *** = $p\leq0.001$.

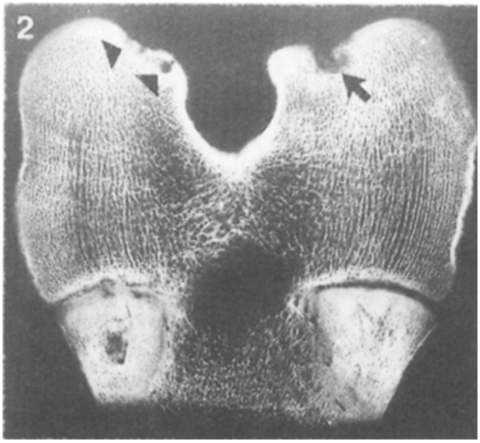


Figure 2. Radiograph of transverse slab of the right femoral condyles. Radiolucent areas in the subchondral bone of the medial (arrow) and lateral (arrowheads) condyles.

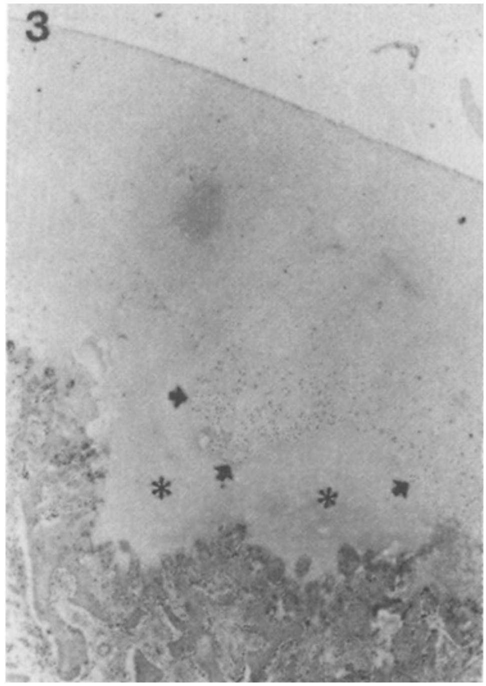


Figure 3. Histologic section from radiolucent area of the medial femoral condyle (same as Fig. 2.). The articular–epiphyseal cartilage complex is thickened with necrotic basal layers (*) retained in the subchondral bone. Clustered chondrocytes (arrows) surround the necrotic cartilage.

Results and discussion

The articular-epiphyseal cartilage of the distal humerus and femur, the metaphyseal growth cartilage of the ulna, and the costochondral junctions were chosen for examination because these are the predilection sites for osteochondrosis in the pig *(Reiland* 1978b). The extent of the lesions in the humerus and the femur were easy to quantify and grade radiologically and were therefore included in the statistical analysis. Also the medial femoral and medial humeral condyles are the sites examined in the Swedish pig progeny testing scheme, which made comparisons with the Swedish Yorkshire population possible.

In 54% of the pigs, 1 or multiple radiologically discernible lesions of osteochondrosis were found in the medial condyles of the right femur and humerus (Fig. 2). Randomly selected samples from 20% of the radilogically discernible lesions were taken for histologic examination. The lesions were characterised by chondronecrosis, impaired ossification, and cartilage retention within the subchondral bone (Fig. 3). In 83% of the pigs there was 1 or several lesions in the medial condyle of the left femur and humerus that were macroscopically classified as osteochondrosis according to the routines of the Swedish pig progeny testing scheme.

The medial femoral and medial humeral condyles were more severely affected, both in frequency and severity, than their lateral counterparts. The most severe radiographic findings, grade 3, appeared almost exclusively at these sites. The osteochondrotic lesions registered were all detected by gross or radiologi-

Table 2. Overall means (x), number of observations, differences between least–squares means for the 2 sexes (♂–♀) and their significance, for the recorded traits.

	$\bar{x}$	No. pigs	♂–♀	Statistical significance[1)]
Macroscopical osteochondrosis scores:				
Left med. femoral condyle	1.59	192	+0.50	**
Left med. humeral condyle	0.65	190	+0.47	***
Radiological osteochondrosis scores:				
Right med. humeral condyle	0.38	188	+0.35	**
Right lat. humeral condyle	0.03	188	–0.03	ns
Right med. femoral condyle	0.89	187	+0.88	***
Right lat. femoral condyle	0.09	188	+0.17	**
Growth parameters:				
Age at slaughter, days	213	195	0	ns
Weight gain, piglets, g/day	199	195	+2	ns
Weight gain, fatten.pigs, g/day	556	195	–4	ns
Weight gain, total, g/day	392	195	0	ns
Skeletal measurements, femur:				
Femur weight, g	278	171	+5	ns
Femur length, mm	198	171	0	ns
Width at epiphysis, mm	57.2	171	+1.5	***
Cortex width, mm	9.7	171	–0.3	ns
Collum angle, degrees	144	171	–1	ns

1) **: p<0.01, ***: p<0.001, ns: not significant.

cal examination. Minute (microscopic) osteochondrotic lesions were not studied. Hence the true prevalence may be higher.

The difference in prevalence according to the radiological (54%) and the macroscopical methods (83%) can be attributed to the following reasons: a) Different methods have been used on bones from different sides. b) The distinction between grade 1 (a slight retention of cartilage) and grade 0 (normal) in the macroscopical method is subjective, and grade 1 will also often include areas with an increase in cartilage thickness not necessarily compromising the subchondral bone.

Osteochondrotic lesions of the costochondral junctions were not possible to evaluate radiologically and are not included in this presentation. Osteochondrotic lesions of the metaphyseal growthplate of the ulna were radiologically discernible (Fig. 4). At histologic examination these areas presented accumulations of hypertrophic chondrocytes with retention of cartilage into the metaphyseal bone (Fig. 5). The radiologically detectable lesions were present in 22% of the population, but since it was not possible to grade them they are not included in the statistical analysis.

The mean values for osteochondrosis data, growth parameters, and bone measurements together with sex-differences are presented in Table 2. Sex-differences were apparent for the osteochondrosis data and for 1 of the bone measurements: epiphyseal width, which was significantly higher for the castrates.

The difference between the 2 sexes regarding osteochondrosis scores, demonstrated earlier (*Reiland* 1978b, *Lundeheim* 1987), was also apparent in this investigation. Castrates

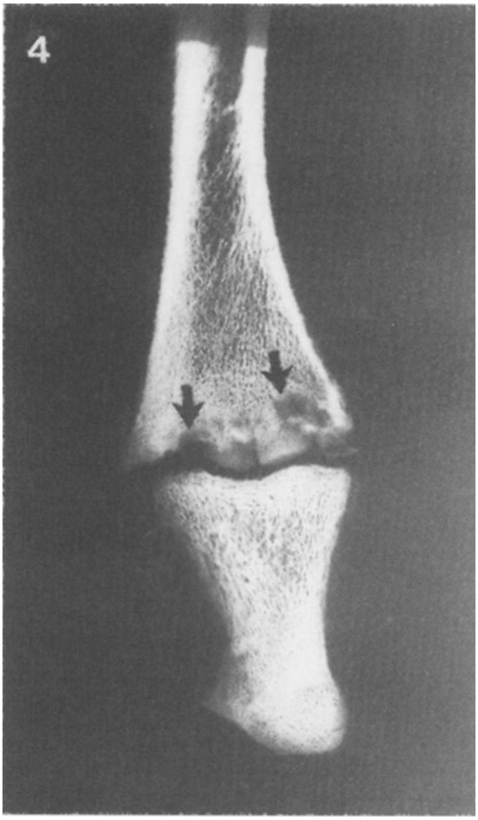


Figure 4. Radiograph of sagittal slab of the distal ulna. Radiolucent areas in the metaphyseal bone (arrows) giving the growth zone a widened and irregular appearance.

Figure 5. Histologic section from the radiolucent areas of Fig. 4. Accumulation of hypertrophic chondrocytes (arrows) projecting into the metaphyseal bone.

had up to twice the prevalence and severity of lesions compared to the gilts, see Table 3. There were no differences in growth rate, age or weight at slaughter between the sexes, but the castrates had wider epiphyses, greater backfat thickness, and a higher fat/muscle ratio than the gilts. The wider epiphyses of the castrates may be indicative of a greater activity in the distal femural growth plate and hence greater vulnerability to trauma and overloading during a period of rapid weight increase. Since there is evidence of direct effects of sex hormones on cartilage cells (*Corvol et al.* 1987) and of an influence of sex hormone on growth hormone release (*Penny et al.* 1972), hormonal factors must be regarded as a potential cause of the male predisposition for osteochondrosis.

Comparison W/Y pigs – purebred Yorkshire pigs
The W/Y pigs had slightly lower mean osteochondrosis scores for the medial humeral condyle and higher mean scores for the medial femoral condyle compared to pure bred Yorkshire pigs in the Swedish progeny testing scheme for 1990 and 1991 examined in Uppsala (Table 4). The osteochondrosis scores for

Table 3. Severity of osteochondrotic lesions expressed as percentage distribution of radiological osteochondrosis scores (score 0 to 3) and as mean radiological osteochondrosis scores at different sites, for gilts (n = 82) and for castrates (n = 106, (med. femoral condyle n = 105)).

Score	Right femur				Right humerus			
	Lateral condyle		Medial condyle		Lateral condyle		Medial condyle	
	♂	♀	♂	♀	♂	♀	♂	♀
0	89.6	100.0	45.7	75.6	98.1	96.3	70.8	90.2
1	6.6	–	13.3	7.3	1.9	3.7	14.2	2.4
2	2.8	–	14.3	12.2	–	–	6.6	6.1
3	0.9	–	26.7	4.9	–	–	8.5	1.2
Mean score	0.15	0.00	1.22	0.46	0.02	0.04	0.53	0.18

the W/Y pigs were corrected for the uneven sex-distribution prior to comparisons with the Swedish Yorkshire pig population data. The prevalence of macroscopical osteochondrotic lesions in the medial humeral and medial femoral condyles was 83% for the W/Y pigs compared to 75% for Yorkshire pigs in the testing scheme. The lesions of the medial humeral condyle were of the same severity in the 2 populations but the W/Y pigs had a greater number of severe lesions in the medial femoral condyle.

Growth rates

The F2-generation of crossbred Wild boars and Swedish Yorkshire pigs provided a population of great genetic heterogeneity. The diversity in growth rate was accentuated through a reduction of the feeding intensity in 1 of the groups. The other 3 groups (N90, L75, L85) were all fed 90% of the SLU-norm which was considered to be close to ad lib feeding for these slow-growing pigs.

At slaughter the mean weight for the whole population was 84.1 kg (SD = 8.9), and the

Table 4. Severity of osteochondrotic lesions expressed as percentage distribution and mean of macroscopical osteochondrosis scores (0 to 5) for the medial condyles of the left humerus and femur for both Yorkshire pigs from the Swedish progeny testing scheme for 1990 and 1991 examined in Uppsala (York.) and the crossbred wild boar – Swedish Yorkshire pigs (W/Y). The number of observations for each group is indicated. The scores for the W/Y pigs have been corrected for the uneven sex-distribution.

Score	Humerus		Femur	
	York. n = 942	W/Y. n = 190	York. n = 942	W/Y. n = 192
0	51.1	56.3	35.1	24.1
1	28.6	30.0	30.1	23.2
2	14.9	9.8	18.0	27.8
3	4.4	3.0	16.6	22.7
4	1.0	0.9	0.2	1.6
5	–	–	–	0.6
Mean score	0.76	0.65	1.17	1.59

Table 5. Least–squares means for the recorded traits for the 4 treatments: 1st batch: N70, N90; 2nd batch: L75, L85. Group N70 was fed 70% of the SLU-norm, groups N90 and L85 were both fed 90% of the SLU-norm and group L75 was fed 90% of the SLU-norm with a decreased lycine level (0.75% instead of 0.85% used in the 3 other treatments). Means with 1 letter in common are not significantly different (p>0.05).

	Treatments			
	N 70	N 90	L 75	L 85
Macroscopical osteochondrosis scores:				
Left med. femoral condyle	2.01a	1.86a	1.23b	1.43b
Left med. humeral condyle	0.43a	0.62a	0.73a	0.72a
Radiological osteochondrosis scores:				
Right med. humeral condyle	0.48a	0.33a	0.47a	0.17a
Right lat. humeral condyle	0.03ab	0.00b	0.00b	0.09a
Right med. femoral condyle	0.89a	0.94a	0.83a	0.77a
Right lat. femoral condyle	0.11a	0.03a	0.15a	0.02a
Growth parameters:				
Age at slaughter, days	223a	204b	213c	214c
Weight gain, piglets, g/day	193a	195a	205a	201a
Weight gain, fatten.pigs, g/day	526a	608b	545a	543a
Weight gain, total, g/day	377a	409b	393c	389ac
Bone measurements, femur:				
Femur weight, g	277a	279a	278a	276a
Femur length, mm	200a	197b	197b	198ab
Width at epiphysis, mm	57.4ab	57.8a	56.9ab	56.6b
Cortex width, mm	9.7a	9.6a	9.7a	10.0a
Collum angle, degrees	142.9a	144.7ab	144.9b	144.0ab

mean age was 213 days (SD = 18). The weight at slaughter varied from 49 to 110 kg, and the daily weight gain from birth to slaughter varied from 205 to 560 g/day with a mean of 392 g/day (SD = 61), a considerably lower growth rate than for pure bred Swedish Yorkshire pigs (570 g/day).

Significant differences between the treatment groups for the recorded parameters are presented in Table 5. The group of the first batch on restricted feeding (N70) had growth rates decreased by 13% compared to the other group (N90). The difference in lycine content between the feeds of the 2 groups of the second batch (L75 and L85) was not great enough to have any significant effects on growth rates or body characteristics. When comparing the 2 groups from different batches but on identical feeding (N90 and L85), group N90 had a 12% higher growth rate. This may be explained as compensatory growth for the piglets of the first batch having grown slower before test.

The significantly decreased growth rate and higher age at slaughter of group N70 did not influence the mean osteochondrosis scores but affected the body conformation as seen in the significantly greater femur length of group N70 .

Residual correlations

Residual correlations were calculated after adjusting the traits for the effects included in the statistical model for the whole population, for the 2 sexes, and within the 8 treatment/ sex-groups. The traits were, however, not

Table 6. Residual correlations and their significance, between recorded growth parameters and osteochondrosis (oc) scores for the epiphyseal predilection sites, for the whole W/Y population and for the two sexes.

Correlations between:	W/Y population	Castrates	Gilts
Average daily weight gain, (total), and oc score for:			
Left medial femoral condyle	+0.2*	+0.1	+0.3**
Right medial femoral condyle	–0.1	–0.2*	+0.2
Left medial humeral condyle	+0.1	+0.1	0.0
Right medial humeral condyle	+0.1	+0.1	+0.2
Average daily weight gain, (piglets), and oc score for:			
Left medial femoral condyle	+0.1	–0.1	+0.2*
Right medial femoral condyle	–0.1	–0.2*	+0.1
Left medial humeral condyle	+0.1	+0.1	+0.1
Right medial humeral condyle	+0.1	+0.1	+0.1
Average daily weight gain, (fattening pigs), and oc score for:			
Left medial femoral condyle	+0.1	+0.1	+0.1
Right medial femoral condyle	–0.1	–0.2	+0.1
Left medial humeral condyle	+0.1	+0.1	–0.1
Right medial humeral condyle	0.0	0.0	+0.1

adjusted for differences in weight at the start of the experiment or at slaughter. Such adjustments would have introduced bias, since the fast growing pigs were more common among the heavier ones.

For the entire W/Y population, significant residual correlations between osteochondrosis scores for different sites were found for the right and left medial femoral condyles (+0.4***), for the right and left medial humeral condyles (r = +0.3***), for the medial humeral and femoral condyles of the left side (r = +0.3***), and for the left medial humeral and the right medial femoral condyle (r = +0.2**).

Significant residual correlations were also seen between total growth rate and osteochondrosis scores for the left medial femoral condyle (r = +0.2*), between weight of the femur and osteochondrosis scores for the left medial femoral condyle (r = +0.3***), and between epicondylar width and osteochondrosis scores for the left and right medial femoral condyles (r = +0.2** and 0.2* respectively).

The residual correlations between the 3 recorded growth parameters: average total daily weight gain, average daily weight gain before the experiment (piglets) and during the experiment (fattening pigs) and the osteochondrosis scores for the predilection sites: left and right medial femoral and humeral condyles are given in Table 6. The correlations for the whole W/Y population were weak (–0.1 to +0.2) and with one exception, not significant. The correlations within the 2 sexes were also weak, the gilts generally having slightly higher figures than the castrates.

The residual correlations between osteochondrosis scores for different sites and between osteochondrosis scores and growth and bone parameters varied considerably and in an unsystematic way between the 8 sex/treatment groups (generally in a range from –0.5 to +0.5).

General discussion

High growth rate and osteochondrosis have been reported to be associated with one an-other for a long time and in several species *(Olsson et al.* 1978b). In the pig, scientific data demonstrating a significant relationship between rapid growth and leg weekness have been reported *(Nakano et al.* 1984, *Lundeheim* 1987) but, existing data on the association between osteochondrosis and rapid growth are contradictory.

Reiland (1978a) managed to decrease the incidence of osteochondrotic lesions in a group of pigs by reducing the growth rate through a restriction of the feed intake to 50% of ad lib consumption, but other studies decreasing the feed intake less drastically have not shown any difference in the incidence or severity of lesions when the growth rate was reduced *(Nakano et al.* 1987).

Woodard et al. (1987) decreased the growth rate of a group of gilts by lowering the protein content of the feed from 16% to 12% but found no effect on the development of osteochondrotic lesions.

Carlson et al. (1988) studied the effects of restricted energy intake, weight, and age on the prevalence of osteochondrotic lesions in 3 groups of gilts. Limited energy intake and reduced growth rate resulted in a 40% lower prevalence of lesions in 9 months old gilts of the same weight as an ad lib fed control group of 7 months old gilts. Gilts on restricted feeding, killed at the same age as the control group but at lower weight, did not show any decrease in prevalence of lesions, and it was suggested that healing of some lesions may have accounted for the decreased prevalence of lesions in the older pigs. Within the groups on restricted feeding there was a significant relationship between daily weight gain and prevalence of lesions and an association between genetically induced rapid growth rate and osteochondrosis was suggested.

This is in accordance with studies of *Reiland* (1978a) and *Klaessen* (1987). *Reiland* (1978a) found that crossbred pigs with a strong genetic background of wild boars (F1 generation rebred to wild boars) had a slow weight gain and did not develop osteochondrosis. *Klaessen* (1987) demonstrated osteochondrotic lesions in the metaphyseal growth cartilage of wild boars but of a lesser degree than in domestic pigs and without clinical symptoms.

In this study the crossbred pigs had a markedly decreased growth rate (c. 30%), but the distribution, frequency and, extent of the osteochondrotic lesions were similar to that of purebred Swedish Yorkshire pigs. The restricted feeding and hence further decreased growth rate in group N70 had no effect on the prevalence or severity of the lesions.

Comparing the treatment groups, no consistent pattern of osteochondrotic lesions was found in the the joints examined, nor any pattern consistent between the sexes within the treatment groups. No unambiguous relationships between the studied growth and bone parameters and osteochondrosis could be found when the different treatment groups and the 2 sexes were compared, nor was there any observed influence of feeding intensity on the occurrence of lesions. For the whole population only weak relationships between the studied growth parameters and osteochondrosis were found.

Conclusions

The present study shows that osteochondrosis occurs in crossbred Wild boar – Yorkshire pigs with a genetically decreased growth rate, raised under the same conditions as ordinary fattening pigs.

Osteochondrosis in the pig is a generalized skeletal disease with possible systemic underlying causes. However, the prevalence of lesions in the crossbred pigs suggests that factors other than feeding regime and overall

growth rate (genetically or nutritionally induced) influence the expression of osteochondrosis.
Additional genetic factors may play an important role in the pathogenesis of osteochondrosis. Hopefully this will be further illuminated in the gene mapping project.

Acknowledgements
The authors would like to thank Marianne Ekwall for her excellent technical assistance, the Nordic Joint Committee for Agricultural Research and the Swedish Farmers Foundation for Agricultural Research for the support provided for this work.

References

Andersson K: SLU-normen – en ny utfodringsnorm till slaktsvin. (The SLU-norm – a new feeding norm for fattening pigs). Fakta – Husdjur 15. Sveriges lantbruksuniversitet, Uppsala, 1984.

Andersson L, Haley CS, Ellegren H, Knott SA, Johansson M, Andersson K, Andersson-Eklund L, Edfors-Lilja I, Fredholm M, Hansson I, Håkansson J, Lundström K: Genetic Mapping of Qantitative Trait Loci for Growth and Fatness in Pigs. Science. 1994, *263,* 1771-1774.

Carlson CS, Hilley HD, Meuten DJ, Hagan JM, Moser RL: Effect of reduced growth rate on the prevalence and severity of osteochondrosis in gilts. Amer. J. vet. Res. 1988, *49,* 396-402.

Corvol M-T, Carrascosa A, Tsagris L, Blanchard O, Rappaport R: Evidence for a Direct in Vitro Action of Sex Steroids on Rabbit Cartilage Cells during Sceletal Growth: Influence of Age and Sex. Endocrinology. 1987, *120,* 1422-1429.

Farnum CE, Wilsman NJ, Hilley HD: An ultrastructural analysis of osteochondrotic growth plate cartilage in growing swine. Vet. Pathol. 1984, *21,* 141-151.

Hill MA: Economic relevance, diagnosis, and countermeasures for degenerative joint disease (osteoarthrosis) and dyschondroplasia (osteochondrosis) in pigs. J. Amer. vet. med. Ass. 1990, *197,* 254-259.

Klaessen R: Untersuchungen über Epiphysenfugen und Gelenkknorpel beim Wildschwein (Studies on the epiphyseal growth plate and joint cartilage of wild boars). Vet. Med. Diss., Zürich, 1987, 83 pp.

Lundeheim N: Genetic analysis of osteochondrosis and leg weakness in the Swedish pig progeny testing scheme. Acta agri. scand. 1987, *37,* 159-173.

Nakano T, Aherne FX, Brennan JJ, Thompson JR: Effect of growth rate on the incidence of osteochondrosis in growing swine. Can. J. Anim. Sci. 1984, *64,* 139-146.

Nakano T, Brennan JJ, Aherne FX: Leg weakness and osteochondrosis in swine: a review. Can. J. Anim. Sci. 1987, *67,* 883-901.

Olsson S-E: Introduction: Osteochondrosis in domestic animals. Acta Radiol. 1978a, Suppl. 358, 9-12.

Olsson S-E, Reiland S: The nature of osteochondrosis in animals. Summary and conclusions with comparative aspects on ostochondritis dissecans in man. Acta Radiol. 1978b, Suppl. 358, 299-306.

Penny R, Blizzard RM: The Possible Influence of Puberty on the Release of Growth Hormone in Three Males with Apparent Isolated Growth Hormone Deficiency. Clinical Endocrinology. 1972, *34,* 82-84.

Reiland S: The effect of decreased growth rate on frequency and severity of osteochondrosis in pigs. Acta Radiol. 1978a, Suppl. 358, 107-122.

Reiland S: Morphology of osteochondrosis and sequelae in pigs. Acta Radiol. 1978b, Suppl. 358, 45-90.

Reiland S, Ordell N, Lundeheim N, Olsson S-E: Heredity of osteochondrosis, body constitution and leg weakness in the pig; a correlative investigation using progeny testing. Acta Radiol. 1978c, Suppl. 358, 123-137.

SAS Institute Inc.: SAS User's Guide: Statistical Version. Ed. 5 Cary, N.C., 1985.

Vogel R: Untersuchungen über Skelettentwicklung und Auftreten von Skelettveränderungen am Os femoris bei Schweinen der DL und Kreuzungstieren DL×Wildschwein in der F1- und F2-Generation (Studies on the development of the skeleton and skeletal deformities of the femur in German Landrace pigs and crossbred German Landrace – wild boar pigs of the F1 and F2 generation). Vet. Med. Diss. Berlin F.U., Berlin, 1976, 92 pp.

Woodard JC, Becker HN, Poulos PW: Effect of diet on longitudinal bone growth and osteochondrosis in swine. Vet. Pathol. 1987, *24,* 109-117.

Sammanfattning
Osteokondros hos vildsvinskorsningar.

Osteokondrosförändringar uppträder i hög frekvens hos växande grisar av samtliga stora svinraser. Osteokondrosförändringarna har sammankopplats med hög tillväxthastighet och anses inte förekomma eller vara betydligt mildare hos långsamväxande grisar. Detta är en studie av förekomsten och graden av osteokondrosförändringar i en population av korsningsgrisar mellan vildsvin och svensk yorkshire. Studien visade att dessa grisar med låg tillväxthastighet hade osteokondrosförändringar av ungefär samma omfattning som renrasiga svenska yorkshire grisar och endast svaga samband mellan de studerade tillväxtparametrarna och osteokondrosförändringarna kunde uppmätas.

(Received February 21, 1994; accepted October 7, 1994).

Reprints may be requested from: H. Uhlhorn, Department of Anatomy and Histology, Swedish University of Agricultural Sciences, P.O. Box 7011, 750 07 Uppsala, Sweden.