

From the Department of Pathology, Veterinary College of Norway,
Oslo.

OSTEOCHONDROSIS AND ARTHROSIS IN PIGS

III. A COMPARISON OF THE INCIDENCE IN YOUNG ANIMALS OF THE NORWEGIAN LANDRACE AND YORKSHIRE BREEDS

By

Trygve Grøndalen

GRØNDALEN, TRYGVE: *Osteochondrosis and arthrosis in pigs. III. A comparison of the incidence in young animals of the Norwegian Landrace and Yorkshire breeds.* Acta vet. scand. 1974, 15, 43—52. — An investigation concerning the occurrence of osteochondrosis and arthrosis in 2 materials totalling 63 pigs of the Landrace breed and 63 of the Yorkshire breed is described. The animals were bred under the same conditions of feeding and housing. The differences should therefore mainly be of genetic origin. Both breeds were highly improved, Landrace the most. In general, Yorkshire pigs showed a lower incidence and a less marked degree of osteochondrosis and arthrosis than Landrace pigs. Statistically significant differences ($P < 0.01$) were demonstrated in the distal epiphyseal plate of the ulna, in the intervertebral joints of the lumbar region and in the medial condyle of the femur in 1 of the materials. The Landrace pigs had longer bodies, broader hindquarters, shorter femurs, and the stifle had a different shape as compared with Yorkshire pigs. There thus seemed to be a connection between exterior features, joint and bone shape and the occurrence of joint lesions. Differences among litters within breed were also demonstrated.

osteochondrosis; arthrosis; breed differences;
pig.

In reviewing the literature, it has been found that the existence of breed differences in the occurrence of leg weakness and skeletal lesions in the pig has been suggested. *Schilling* (1963) mentioned that imported, improved Dutch Landrace pigs showed a high incidence of arthrosis. *Sabec* (1967) described the occurrence in Yugoslavia of a higher incidence of epiphyseal separation of the tuber ischii in young imported Swedish Land-

race gilts than in other breeds. *Hansen & Reiland* (1968) considered that arthrosis is more widespread in Swedish Landrace than in Yorkshire pigs. Furthermore, *Zimmerman* (1959—60) revealed histomorphological breed differences when investigating the femur.

Information obtained under practice conditions is often based on observations made on animals from different environments. In the 2 trials which are described in this article, efforts were made to ensure that as far as possible the conditions under which the animals were kept were the same. The trials took place over the period 1970 to 1972.

MATERIALS AND METHODS

Material I

This consisted of 7 litters totalling 45 gilts or castrates of the Norwegian Landrace breed, and the same number of litters and pigs of the Yorkshire breed. The Landrace pigs were the progeny of 7 different sows at the Veterinary College of Norway's research station, Arteid, and 5 different boars. The Yorkshire pigs were from 4 different bought-in sows and 4 different boars. Thus 3 of the Yorkshire sows each had 2 litters taking part in the trial. The sows were artificially inseminated, and all were housed at the Arteid research station, and fed the same ration. All pigs were born in the same farrowing house. Each time a Yorkshire sow farrowed, a Landrace litter with about the same number of pigs as the Yorkshire litter was chosen for comparison. They were placed in the same fattening section, given the same ration and kept under as similar conditions as was practically possible.

The ration fed was a commercial pig-ration containing about 0.7 % calcium, 0.6 % phosphorus and 14 % digestible crude protein. The animals were fed twice daily, the level of feeding being about the average under Norwegian conditions.

The most obvious exterior differences between the breeds were noted. The pigs were slaughtered between 95 and 105 kg live weight. Both forelegs, both hindlegs, pelvis and the lumbar region of the vertebral column were subjected to post-mortem examination for joint and bone lesions. Subjective appraisal was made according to a scale ranging from 1 to 5; 1: normal, 2: mild degree lesion, 5: severe degree lesion. Judgment was based on the extent and depth of the lesions, on the presence of deposits

and on the degree of deformation. One cone-shaped projection in the distal epiphyseal plate of the femur was judged as 2, 2 projections as 3 and 3 projections as 4. Several of the bones' structural anatomical features were measured post mortem. Measuring methods used will be described later (*Grøndalen 1974 c*). All individual observations were transferred onto punch cards, and statistical calculations carried out according to standard methods of statistical analyses*. Which breed or litter the pig belonged to was unknown at the post-mortem examinations.

Material II

This consisted of 36 pigs in all. There were 6 litters with 6 gilts or castrates in each of the litters, 3 litters were Yorkshire from 2 different herds, while 3 were Landrace from 3 different herds. The pigs were divided into 6 groups of 6 pigs as follows: 3 Yorkshire litter-mates were put together with 3 Landrace litter-mates to form group 1, the remaining litter-mates from the 2 litters forming group 2, and so on. Group 2, 4 and 6 were given 20 min. exercise at a brisk walking pace on a cement floor 3 times a week from the time they were first included in the trial at 25 kg live weight until they were slaughtered at 117—123 kg live weight. Feeding was as for material I. The pigs were examined prior to slaughter and judgment made of their exterior features and gait. This and the effect of exercise will be described in a later article. Post-mortem examination was carried out as for material I. In addition, sections were taken for histological examination from the costochondral junctions of the ribs and from areas of joint and bone showing lesions. The sections were treated as previously described (*Grøndalen 1974 a*).

RESULTS

In both breeds, the main lesions in joints and bones consisted of osteochondroses and arthroses.

Material I

The Landrace pigs were on average 197 days old at slaughter, the corresponding figure for the Yorkshire pigs being 199 days. In carcase classifying, 95.6 % of the Landrace pigs were put into

* The statistical calculations were carried out at the Computing Centre, Agricultural University of Norway.

1 of the 2 best classes, while 71.1 % of the Yorkshire pigs obtained this. None of the animals had any serious locomotory problems. On clinical subjective examination, the Landrace pigs appeared to have longer backs, as well as narrower lumbar region and broader hindquarters than Yorkshire pigs. Post-mortem examination of bone and joint shape demonstrated a number of differences between the 2 breeds. These involved, in this material, the back, hips, pelvis and stifle joint. Although the methods used in taking measurements, and the connection between joint shape and joint lesions will be returned to in a later article, a summary of the main differences which were noted, and a few average figures will be given here. The following differences were statistically significant at, at least, the 1 % level ($P < 0.01$): The distance between the outer surfaces of the articular processes of the first lumbar vertebra was 2.85 cm in Landrace, as compared with 2.98 cm in Yorkshire pigs. The ilium was longer in Yorkshire pigs, although the distance between the medial anterior border of the pubis (pecten ossis pubis) and the first sacral vertebra was nearly the same in both breeds. The angle between the ventral aspect of the ilium and the ventral aspect of the first sacral vertebra was 124.1° in Landrace and 120.7° in Yorkshire pigs. The head of the femur was flatter and less spherical in Landrace than in Yorkshire. In Landrace pigs, the top of the head of the femur and the trochanter major were at the same level according to the length axis of the femur, whereas in Yorkshire pigs, the trochanter major was on average 4 mm below the level of the head of the femur. The condyle/length axis angle of the femur, measured medially, was 88.2° in Landrace and 90.5° in Yorkshire pigs. The twisting of the medial condyle of the femur according to the length axis was 12.1° in Landrace and 7.4° in Yorkshire pigs. The femur was shorter in Landrace than in Yorkshire, 19.6 cm as compared with 20.1 cm, while the reverse was true in the case of the tibia, this being on average 18.6 cm long in Landrace and 18.4 cm in Yorkshire. However, the difference in length of the tibia was not statistically significant. The difference in height between the lateral and medial part of the intercondyloid eminence on the proximal joint surface of the tibia, according to the condyles, was 2.5 mm in Landrace and 1.7 mm in Yorkshire pigs.

The results of the patho-anatomical examination of bones and joints in material I are shown in Table 1.

Table 1. Incidence of lesions in the joints and the bones, mean lesion score and significance for breed differences in material I.

Diagnosis	Landrace			Yorkshire			Significance for breed differences (P) calculated on lesion score
	incidence		mean lesion score	incidence		mean lesion score	
	number	%		number	%		
total affected pigs	45	100.0	1.9	43	95.6	1.5	P < 0.01
osteochondrosis and arthrosis in the joint cartilage of the scapula	37	82.2	2.0	32	71.1	1.8	n.s.*
osteochondrosis and arthrosis in the elbow joint	20	44.4	1.8	16	35.6	1.5	n.s.
osteochondrosis in the distal epiphyseal plate of the ulna	31	68.9	2.1	15	33.3	1.4	P < 0.01
arthrosis in the lumbar intervertebral joints	15	33.3	1.6	2	4.4	1.0	P < 0.01
degenerated lumbar intervertebral discs	8	17.8	1.2	6	13.3	1.2	n.s.
osteochondrosis and arthrosis in the medial condyle of the femur	39**	86.7	2.9	23***	51.1	1.6	P < 0.01
projections in the distal epiphyseal plate and the metaphysis of the femur	12	26.7	1.3	7	15.6	1.2	n.s.
osteochondrosis distal in the talus	33	73.3	2.1	34	75.6	2.0	n.s.

* n.s.: not significant ($P > 0.05$).

** five of the pigs, or 11.1 % had "open" lesions (arthrosis) in the medial condyle of the femur.

*** no pig had arthrosis in the medial condyle of the femur.

Material II

At slaughter, the Landrace pigs were on average 234 days old, and the Yorkshire pigs 250 days old. Age difference was already present at 25 kg live weight, the Landrace pigs reaching this weight at an average of 82 days, while the Yorkshire pigs took on average 96 days.

There were great differences in locomotory ability between individuals and litters, but no obvious breed differences. Exterior breed differences demonstrated clinically in material I were also

present in material II. There were also appreciable differences in the development of the hindquarters within breeds.

Post-mortem examination of joint and bone shape demonstrated several statistically significant differences between litters, whereas the only statistically significant difference demonstrated between breeds concerned the length of the femur ($P < 0.05$). The length of the femur was on average 21.2 cm in Landrace and 21.8 cm in Yorkshire. The corresponding figures for the tibia were 19.8 cm and 19.9 cm. The shape of joints and bones, exterior features and locomotory ability will be referred to in a later article.

The vertebral column was subjected to post-mortem examination in only 6 Yorkshire and 3 Landrace pigs. Arthrosis of the lumbar intervertebral joints was observed in 2 animals of each breed.

Evidence of rickets or of generalized osteodystrophia fibrosa was not demonstrated on histological light-microscopic examination of sections from the costochondral junction in material II. Neither were breed differences in the occurrence of eosinophilic

Table 2. Incidence of lesions in the joints and the bones and mean lesion score in material II.

Diagnosis	Landrace			Yorkshire		
	incidence		mean lesion score	incidence		mean lesion score
	number	%		number	%	
total affected pigs	18	100.0	1.7	17	94.4	1.3
osteochondrosis and arthrosis in the elbow joint	8	44.4	1.6	5	27.8	1.4
osteochondrosis in the distal epiphyseal plate of the ulna	14	77.8	2.0	5	27.8	1.4
arthrosis in the hip joint	3	16.7	1.2	0	0.0	1.0
osteochondrosis and arthrosis in the medial condyle of the femur	10*	55.6	2.3	5*	27.8	1.4
projections in the distal epiphyseal plate and the metaphysis of the femur	8	44.4	1.9	3	16.7	1.1
osteochondrosis and arthrosis distal in the talus	15	83.3	2.1	8	44.4	1.4

* no pig had arthrosis in the medial condyle of the femur.

streaks or other small abnormalities in the cartilage demonstrated. Sections from joint and bone lesions in the medial condyle of the humerus, medial condyle of the femur and from the distal epiphyseal plate of the ulna showed a picture of osteochondrosis and arthrosis, often undergoing a marked process of repair. Morphological differences between the 2 breeds as regards the bone spicules and cartilage were not demonstrated.

The results of the gross patho-anatomical examination of joints and bones in material II are shown in Table 2.

DISCUSSION AND CONCLUSIONS

In the trials described above, the rate of growth was nearly the same for the breeds examined, and was not especially high. As regards carcass quality, Landrace pigs in material I was a little better than the Yorkshires. However, animals from both breeds must be considered as being highly improved, this being especially true in the case of the Landrace breed.

The pigs in material I were as far as possible subjected to the same environment right from the time of conception. The pigs in material II were kept under different environmental conditions up to 25 kg live weight. When put into trial, however, the Landrace/Yorkshire groups were as far as possible kept under the same conditions. The differences which were observed should therefore be due mainly to genetical factors. The lesions demonstrated were in both breeds identical with previously described lesions in pigs (*Grøndalen* 1974 a, b) where the nomenclature used is also discussed.

In general, the incidence of osteochondrosis and arthrosis was lower in Yorkshire pigs, though the most significant differences seemed to be mainly located at certain parts of the skeleton. There was good agreement between materials I and II.

Differences in material I were statistically significant as regards total lesion score, the distal epiphyseal plate of the ulna, the medial condyle of the femur, and the lumbar region of the vertebral column.

It could be expected that, because of their greater age and weight, the pigs in material II would have shown more severe arthrotic lesions in the intervertebral joints than the pigs in material I (*Grøndalen* 1974 a, b). However, due to errors in cutting and boning-out, the vertebral columns of only 9 of the pigs

in material II were examined. Arthrosis in the vertebral column occurred in both breeds, but the material is too small for a proper comparison of the 2 breeds.

In previous investigations (Grøndalen 1974 a), it was demonstrated that the pigs at the Arteid research station show a higher incidence of osteochondrosis and arthrosis than is shown in slaughter pigs in general, and they are therefore not representative of the breed. Thus some degree of reservation must be made with regard to the general application of the difference demonstrated between the breeds. However, the results show that the incidence of osteochondrosis in the distal epiphyseal plate of the ulna and in the medial condyle of the femur seems to be low in Yorkshire pigs, even when compared with other investigated materials (Grøndalen 1974 a). The occurrence of arthrosis in the lumbar region of the vertebral column also seems to be less frequent in the Yorkshire, both when compared with Landrace pigs at the Arteid research station and also with those from other breeders (Grøndalen, unpublished).

The exterior difference between the breeds was especially apparent with regard to body length and the structural development of the hindquarters. In Yorkshire pigs, as compared with Landrace, the femur was longer, the tibia was about the same length, and the back seemed to be shorter. The relationship between back, femur and tibia was therefore different in the 2 breeds. Moreover, the shape of the pelvis, femur and tibia was found to be different between the breeds. This confirmed the findings of Schilling (1963) in Germany.

As already mentioned, significant differences in patho-anatomical findings were present in the lumbar region of the vertebral column and in the femorotibial joints. The results suggest that a long back, broad hindquarters and short femur, together with a special shape of the pelvis, femur and tibia may have an undesirable effect on the stifle joint and back. This is in line with the thinking of Schilling who mentions great back-length and special shape of the hams as being important factors in the leg weakness complex.

The histological examinations carried out were of a routine nature, and concerned cartilage and spongy bone substance. It was therefore not possible to demonstrate the differences between breeds described by Zimmermann (1959—60) as regards the structure in the compact bone.

A Landrace litter from the Arteid research station was included in material II. This litter distinguished itself by showing a high incidence and degree of osteochondrosis and arthrosis. Feeding trials have also shown differences between litters (Nielsen *et al.* 1971, Grøndalen 1972). However, litter differences will be returned to in a later article.

To conclude, it seems that differences in joint lesions between breeds do occur; that there seems to be a connection between exterior features, joint shape and joint lesions; and that differences in the occurrence of lesions may be partly due to this.

ACKNOWLEDGEMENTS

Thanks are due to the Department of Animal Husbandry and Genetics, Veterinary College of Norway for help in obtaining and housing the pigs, and to the Computing Centre, Agricultural University of Norway for help with the statistical processing of the findings.

REFERENCES

- Grøndalen, T.: Anatomical construction of the elbow and the knee joints in relation to joint lesions in young pigs. Proc. 2. I.P.V.S. Congr., Hannover 1972, 67.
- Grøndalen, T.: Osteochondrosis and arthrosis in pigs. I. Incidence in animals up to 120 kg live weight. Acta vet. scand. 1974 a, 15, 1—25.
- Grøndalen, T.: Osteochondrosis and arthrosis in pigs. II. Incidence in breeding animals. Acta vet. scand. 1974 b, 15, 26—42.
- Grøndalen, T.: Osteochondrosis and arthrosis in pigs. VII. Relationship to joint shape and exterior conformation. Acta vet. scand. 1974 c, 15, Suppl. 46. In press.
- Hansen, H.-J. & S. Reiland: Ledlidanden hos avelssvin. (Joint lesions in breeding pigs). Lact. Symp. Wenner-Gren Center, Stockh. 1968, 105—111.
- Nielsen, N. C., S. Andersen, A. Madsen & H. P. Mortensen: Dietary calcium-phosphorus rations for growing pigs in relation to serum levels and bone development. Acta vet. scand. 1971, 12, 202—219.
- Sabec, D.: Untersuchungen über die Ablösung der Sitzbeinhöcker (Apophyseolysis) bei Jungsauen. (Investigations on epiphyseolysis of tuber ischii in young sows). Dtsch. tierärztl. Wschr. 1967, 74, 489—491.
- Schilling, E.: Rassenunterschiede am Skelett des Beckens und der Hinterextremitäten beim Schwein. (Skeletal differences in the pelvis and the hind legs between pig breeds). Z. Tierzüchtg Züchtgsbiol. 1963, 78, 293—324.
- Zimmerman, W.: Untersuchungen am Femur des Hausschweines. (Investigations on the femur of pigs). Z. wissenschaft. Zool. 1959—60, 162, 96—127.

SAMMENDRAG

Osteochondrose og arthrose hos gris. III. En sammenligning av forekomst hos unge dyr av norsk landrace og yorkshire.

Forekomst av osteochondrose og arthrose er beskrevet etter undersøkelse av 63 landsvin og 63 yorkshire. Dyra ble oppdrettet i samme miljø. Forskjellene skulle derfor hovedsakelig være av genetisk natur. Begge rasene var sterkt foredlet, landsvin mest. Generelt hadde yorkshire lavere frekvens og mildere grad av osteochondrose og arthrose enn landsvin. I distale epifyseplate av ulna, i intervertebral-ledda i lumbalregionen og i mediale condyl av femur var forskjellen statistisk sikker ($P < 0.01$) i ett av materialene. Landsvin hadde lengre kropp, bredere bakpart, kortere femur og en annen utforming av kneleddet enn yorkshire. Det var derfor tilsynelatende en sammenheng mellom eksteriøre bygningstrekk, utforming av ledd og knokler og leddlesjoner. Det ble også påvist forskjeller mellom kull innen rase.

(Received September 13, 1973).

Reprints may be requested from: Trygve Grøndalen, Veterinary College of Norway, Postboks 8146, Oslo Dep., Oslo 1, Norway.