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## OSTEOCHONDROSIS AND ARTHROSIS IN PIGS

### II. INCIDENCE IN BREEDING ANIMALS

By  
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GRØNDALEN, TRYGVE: *Osteochondrosis and arthrosis in pigs. II. Incidence in breeding animals.* Acta vet. scand. 1974, 15, 26—42. — Joint and bone lesions in Norwegian breeding pigs are described on the background of an investigation involving 174 sows and 155 boars from 7 months to 4½ years old. Lesions, which consisted predominantly of arthrosis, degeneration of intervertebral discs, spondylosis and epiphyseal separations, were demonstrated frequently in both sexes. Osteochondrosis, a condition previously demonstrated frequently in slaughter pigs, had either completely healed, undergone repair or developed into an arthrosis by the time the animal reached an age of about 1½ years.

Whereas a higher incidence of arthrosis of the intervertebral joints was found in boars than in sows, the reverse was true as regards degeneration of the intervertebral discs and anchylosing spondylosis. Possible reasons for this are discussed. Norwegian pigs show a higher incidence of lesions in the lumbar region of the vertebral column than has been described up to the present time in other countries.

osteochondrosis; arthrosis; pig.

A high incidence of osteochondrosis in joints and epiphyseal plates, and arthrosis, especially in the lumbar intervertebral joints, the distomedial hock joints, the elbow and stifle joint in pigs up to 120 kg live weight has been previously described (Grøndalen 1974). A review of the literature showed that osteochondrosis and arthrosis are widespread in pigs in various countries. Neither is epiphyseal separation uncommon. Among others, *Duthie & Lancaster* (1964) have described separation of the head of the femur, and *Pettersson & Reiland* (1967) separation of the tuber ischii.

In order to record the incidence of osteochondrosis and arthrosis in breeding animals, and to determine which joints and bones were most commonly and seriously affected, skeletons from sows and boars were collected during the period 1970—72.

## MATERIALS AND METHODS

### *Material I*

This comprised 83 Norwegian Landrace boars, from 7 months to 4½ years old, for which the reason for slaughter was known. Out of these, 67 had been sent for routine examination at the Department of Pathology from boar stations, while the remaining 16 had been sent from various sources for post-mortem examination because of leg weakness. The material was therefore selected. The lumbar region and the proximal joints of the extremities were examined. The distal parts of the extremities together with the carpal and tarsal joints had been routinely removed during the slaughtering process.

### *Material II*

This comprised 91 Norwegian Landrace sows, from 9 months to 4 years old, from the Veterinary College of Norway's research station, Arteid. Reasons for slaughter included reduction in herd numbers, reproductive problems, leg weakness etc. The lumbar region of columna and joints of the extremities were examined.

### *Material III*

This comprised 72 randomly selected boars more than 120 kg live weight examined at a slaughter-house. The reason for slaughter was unknown. The elbow and femoro-tibial joints were examined, these being easily available for on-the-spot examination.

### *Material IV*

This comprised 83 randomly selected sows examined at a slaughter-house. The reason for slaughter was unknown. All had had at least 1 litter. Carcases were split along the line of the vertebral column. The intervertebral discs and vertebral bodies were examined. For economic reasons (sale value), further examinations were not carried out.

The gross post-mortem inspection included examination for ruptures and haemorrhages in the joint capsules and ligaments, examination for arthritis, osteochondrosis and arthrosis, and examination for patho-anatomical conditions of the intervertebral discs. The nomenclature used is the same as previously described (*Grøndalen* 1974). All materials were not examined fully, as will be seen from the section dealing with the results.

Sections at right angles to the surface in the longitudinal direction of the bones from sites showing cartilage or bone lesions, and sagittal sections through the vertebral bodies and intervertebral discs, were taken for histological examination. The sections were treated as previously described (Grøndalen).

## RESULTS

### *Gross examination*

Osteochondrosis, which showed a high incidence in slaughter pigs (Grøndalen 1974), was demonstrated at the same sites in young breeding animals, though less commonly in animals more than 1½ years old. If the superficial part of the joint cartilage was damaged, there were usually cartilage proliferations, osteophyte formation, and joint mice. Such arthrotic changes were most often demonstrated in the elbow joint. Villous proliferations were often present in the synovial layer of the joint capsule. Bacteriological investigation of 8 such capsules was negative.

### *Materials I and II*

The severity and incidence of the most common lesions in materials I and II are shown in Tables 1 and 2. Changes were,

Table 1. Pathological findings in the skeleton, degree and incidence in material I (boars).

Diagnosis	Severe degree lesions		Mild degree lesions	
	number	%	number	%
arthrosis in the shoulder joint	1	1.2	24	28.8
arthrosis in the elbow joint	24	28.9	23	27.7
arthrosis in the lumbar joints	11	16.0*	44	63.8*
degenerated intervertebral discs in the lumbar region	4	5.8*	15	21.7*
ankylosing spondylosis in the lumbar region	3	4.3*		
arthrosis in the hip joint	3	3.6	36	43.4
epiphyseolysis of the head of the femur	4	4.8		
epiphyseolysis of the tuber ischii	1	1.2		
arthrosis in the femoro-tibial joint	14	16.9	43	51.8

\* the lumbar region was examined in 69 of the 83 animals.

Table 2. Pathological findings in the skeleton, degree and incidence in material II (sows).

Diagnosis	Severe degree lesions		Mild degree lesions	
	number	%	number	%
arthrosis in the shoulder joint	4	4.4	10	11.0
arthrosis in the elbow joint	13	14.3	30	33.0
arthrosis in the lumbar joints	11	12.1	39	31.9
degenerated intervertebral discs in the lumbar region	29	31.9	12	13.2
ankylosing spondylosis in the lumbar region	22	24.2		
arthrosis in the hip joint	3	3.3	14	15.4
epiphyseolysis of the head of the femur	2	2.2		
epiphyseolysis of the tuber ischii	3	3.3		
arthrosis in the femoro-tibial joint	9	9.9	50	54.9
arthrosis in the talus	2	2.2	29	31.9
arthrosis in the mediiodistal tarsal joints	22	24.2	40	44.0

for the most part, symmetrical. Two of the boars in material I had infectious polyarthritis together with arthrosis. Monoarthritis occurred occasionally. The degenerative changes in the various joints will be described separately.

*Shoulder joint.* The condition in the tables named mild degree lesion in the shoulder joint was a wearing away of the lateral part of the joint surface of the scapula, often with osteophyte formation along the edge (Fig. 1). Worn-down cartilage on the head of the humerus was also observed. Out of the 24 boars in material I with this condition, 19 were more than 1½ years old. Marked arthrotic changes in the joint were uncommon.

*Elbow joint.* Changes demonstrated in the elbow joint included worn-down cartilage, collapse of subchondral bone tissue, chip fractures, joint mice, osteophyte formation along the joint edge and villous proliferation in the joint capsule (Fig. 2). The medial condyle of the humerus was most often affected. Changes varied greatly in degree and size, and probably represented a further progression of osteochondrosis. They were demonstrated frequently in all age groups. Arthrotic lesions were judged subjectively, according to their extent and to the degree to which the joint was deformed, as being of severe or mild degree.

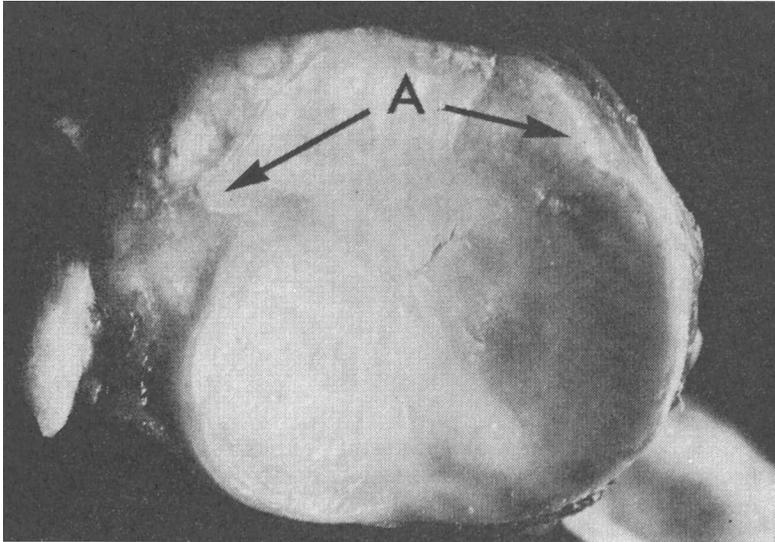


Figure 1. Worn-down lateral border of the joint surface of scapula (A) of a 2 years old boar.

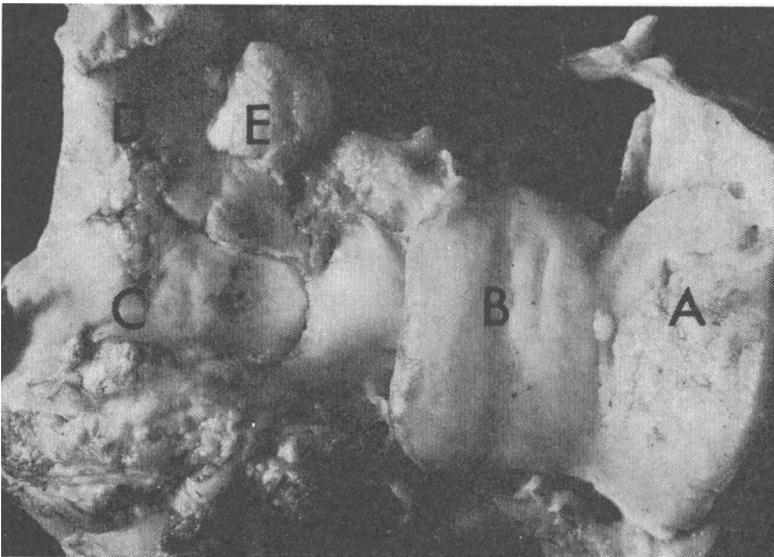


Figure 2. Cartilage lesions, osteophyte formations and joint mouse in the elbow joint of a 16 months old boar.  
A: medial- B: lateral condyle of humerus. C: joint surface of radius. D: semilunar notch. E: joint mouse.

*Vertebral column.* Ten of the boars were examined for pathological changes in the thoracic region. Changes occurred, but were, in these 10 boars, of a much lesser degree of severity and incidence than those found in the lumbar region, which was examined in 69 of the boars in material I and all the sows in material II. Chip fractures, joint mice, osteophyte formation, and deformed joint surfaces in the lumbar intervertebral joints were common findings (Fig. 3). One boar had 12 joint mice, up to the size of a pea, in the lumbar region. Arthrosis was judged as being of severe or mild degree as described in the chapter about the elbow joint, the number of joints affected also being taken into consideration. Three of the boars in material I with severe degree of arthrosis in the lumbar joints had a markedly distorted vertebra with unilateral contact with the ilium (Fig. 4). Degenerated intervertebral discs were most common in sows. As regards the boar material, 1 boar with severe degeneration of the intervertebral discs also showed epiphyseal separation of the 4th lumbar vertebra, with compression myelitis and posterior paralysis as the result. Prolapse into the vertebral bodies occurred (Fig. 5). Most often these prolapses also penetrated the epiphyseal plate. Complete rupture of the annulus fibrosus with prolapse of the nucleus pulposus either dorsally or ventrally was not observed. The condition described as a mild degree of degeneration in the intervertebral discs was a granular, quite firm, often slightly yellowish nucleus pulposus. In this material only anchylosing spondylosis was recorded and therefore all these cases are classified as being of a severe degree. In 15 (68.2 %) of the 22 sows in material II with anchylosing spondylosis, changes were localized to the lateral aspects of the vertebral bodies. Macroscopically obvious degenerative changes in the nucleus pulposus were observed in all but 2 of the 22 sows with anchylosing spondylosis. Bacteriological examination of 7 of the affected intervertebral discs was negative.

*Hip joint.* Rupture of the teres ligament was found in 5 of the boars in material I, being unilateral in 2 cases. In 3 of the animals with rupture of the teres ligament, there was a wear surface cranioventrally on the edge of the acetabulum (Fig. 6), and worn-down cartilage on the head of the femur. The condition was described as being of a severe degree when the head of the femur as well as the acetabulum were affected. Otherwise, the most common finding was a low femoral head, up to 4 cm below the

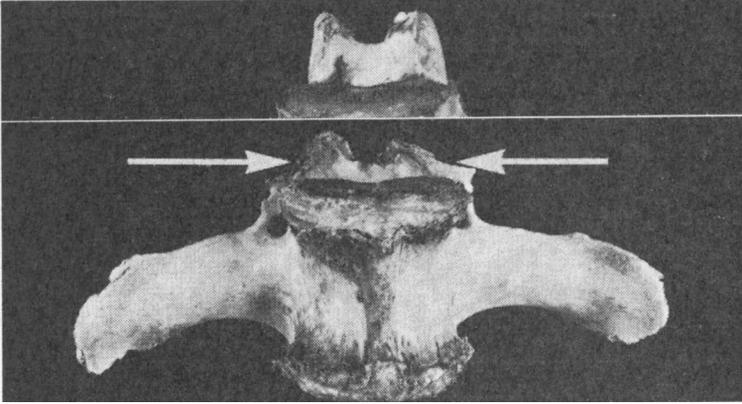


Figure 3. Osteophyte formations and joint surface deformation (arrows) in a lumbar intervertebral joint of a 1 year old boar. The upper part of the figure shows normal articular processes.

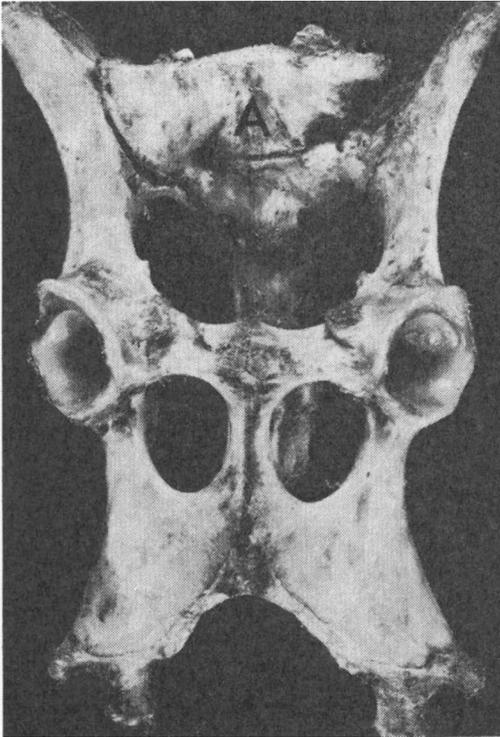


Figure 4. Distorted vertebra (A) with unilateral contact with the ilium of a 2½ years old boar.

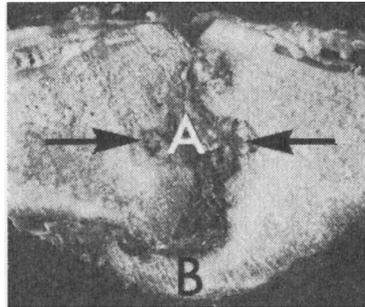


Figure 5. Section showing degenerated intervertebral disc (A) and spondylosis (B) of a sow. Necrosis (arrows) in the vertebral bodies.

level of the trochanter major, which itself seemed to be of normal shape and size (Fig. 7). The teres ligament and joint cartilage, in the acetabulum as well as on the head of the femur, were usually intact. In some cases, however, there was a crest on the head of the femur against the neck, and the head was occasionally flattened off with osteophyte formation along the joint edge (Figs. 7 and 8). In most of these cases, as early as 7 months of age, the epiphyseal plate was partly closed as shown in Fig. 8. When the acetabulum was unaffected, the low femoral head was termed mild degree arthrosis. Thickening of the capsule and acute capsule reaction occurred. Epiphyseal separation of the head of the femur occurred only in animals less than 1 year old. In 2 cases, such separation was bilateral.

*Tuber ischii.* The 4 cases of epiphyseal separation of the tuber ischii were unilateral and showed fibrous repair and neoarthrosis.

*Stifle joint.* The lesion described as severe degree arthrosis was a more or less repaired deep lesion on the medial condyle of the femur. Such lesions could also be demonstrated by radiographical examination (Fig. 9). As regards material I, 13 of the 14 boars showing this type of lesion were under the age of 1½ years. The lesion described as mild degree arthrosis comprised dull, frayed superficial cartilage with a large number of small transverse clefts, sometimes occurring as a large furrow along the medial condyle of the femur (Fig. 10). Together with these changes, there was often frayed cartilage on the medial part of the intercondyloid eminence of the tibia. These changes were seen most commonly in older animals. The central part of the medial meniscus was frayed in 5 of the sows in material II (Fig. 11).

*Tarsus.* Arthrosis of the hock joint occurred most often between the third tarsal and third metatarsal bone, but also between the third tarsal and the central tarsal bone, mediolaterally on the tibial tarsal bone, and occasionally in the lateral parts of the joint.

All animals which showed changes in the talus in material II also had changes in the mediolateral sections of the hock joint. In these cases the cartilage was eroded, with the occasional presence of adhesions. Osteophyte formation along the joint edge was at times very marked (Fig. 12). The degree of severity of the patho-anatomical changes was judged as described in the chapter about the elbow joint. Only 25 of the animals in material

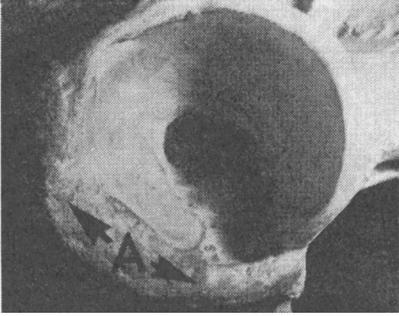


Figure 6. Worn-down cranioventral border of acetabulum (A) of a 2 years old boar.

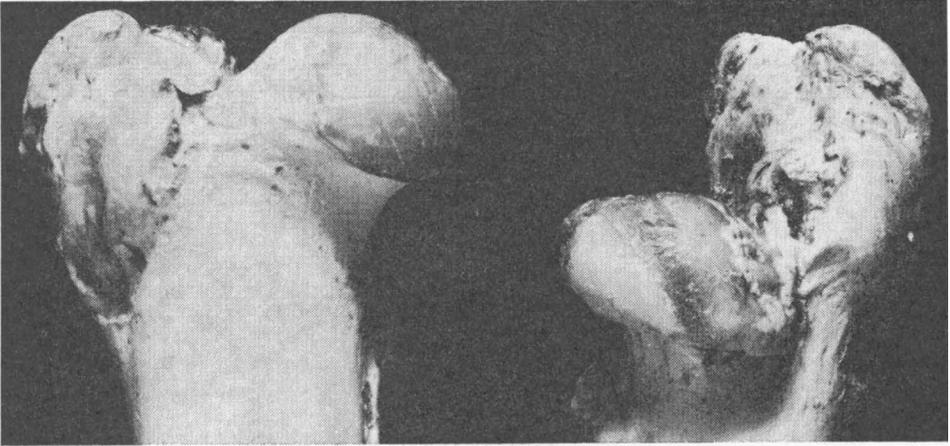


Figure 7. Low deformed head of the femur of a 3½ years old boar. Normal head of femur to the left.

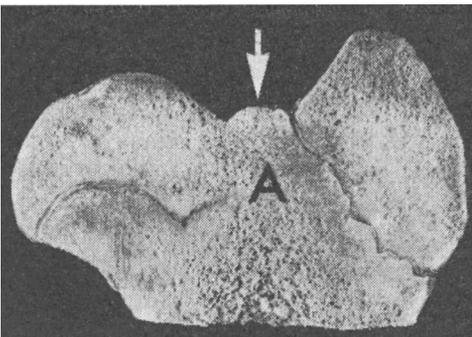


Figure 8. Low head of the femur with a crest (arrow) against the femoral neck and partly closed epiphyseal plate (A) of a 7 months old boar.

I were examined for this type of lesion. Most of these were young, 40 % showed changes.

### *Material III*

Severe degree arthrosis was demonstrated in the elbow joint of 24 (33.3 %) of the 72 boars, and mild degree arthrosis in 17 (23.6 %). Severe degree arthrosis was demonstrated in the stifle joint of 6 animals (8.3 %), all of which were less than about 150 kg live weight at slaughter. Frayed, cracked cartilage was found on the medial condyle of the femur in 32 animals (44.4 %). All these were older animals.

### *Material IV*

Severe degree degeneration of the lumbar intervertebral discs was demonstrated in 20 (24.1 %) of the 83 sows in material IV, while mild degree of degeneration was found in 9 (10.8 %). Twenty-six sows (31.3 %) showed ankylosing spondylosis in the lumbar region of the vertebral column. About 70 % of the lesions in the lumbar region in this material were confined to the first and second lumbar vertebrae and to the last lumbar and first sacral vertebrae. There was mild degree intervertebral disc degeneration and ankylosing spondylosis in the thoracic region in 8 animals (9.6 %). In 7 of these, the changes were in the caudal thoracic vertebrae. All 8 had, at the same time, changes in the lumbar region. In 2 animals, in which lesions of the vertebral column were otherwise not demonstrated, there was an obvious local ventral bowing of 2 or 3 thoracic vertebrae. This seemed to be either an old damage or a development disturbance.

### *Histological examination*

Histological examination showed that the lesions in the medial condyle of the humerus, medial condyle of the femur, and distal epiphyseal plate of the ulna in the youngest animals had undergone a significant degree of repair, mainly in the form of bone resorption and connective tissue infiltration. Histological examination of the dull, frayed cartilage from the medial condyle of the femur usually demonstrated that the deeper cartilage and underlying bone tissue were normal. Superficially, the outer layer was either completely absent or in pieces. There were transverse clefts, some of them deep, in the cartilage. The carti-

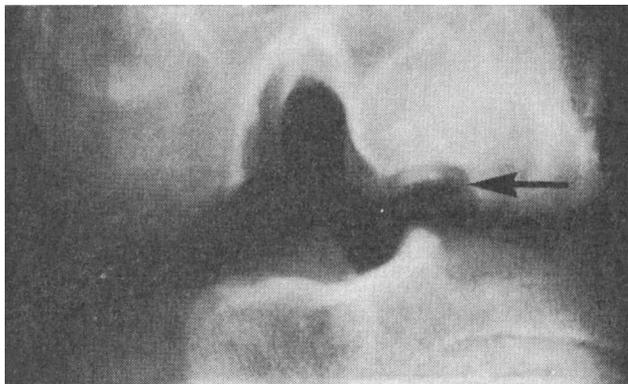


Figure 9. Radiograph showing lesion (arrow) in the medial condyle of femur of an 8 months old boar.

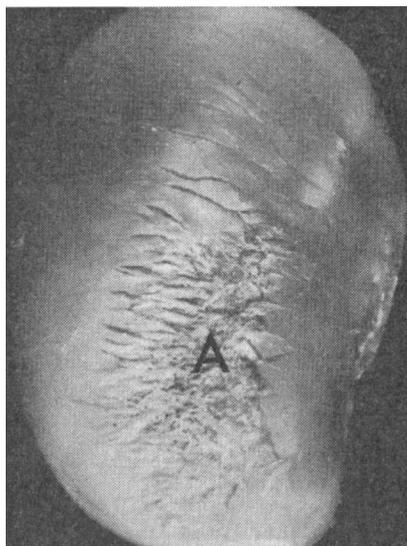


Figure 10. Frayed cartilage surface (A) of the medial condyle of femur of a 2 years old boar.

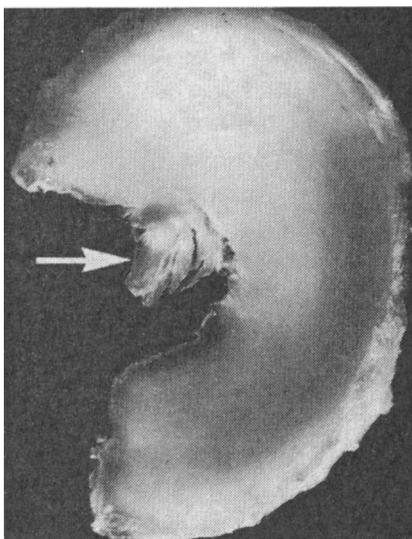


Figure 11. Frayed medial meniscus (arrow) of the stifle joint of a 1½ years old sow.

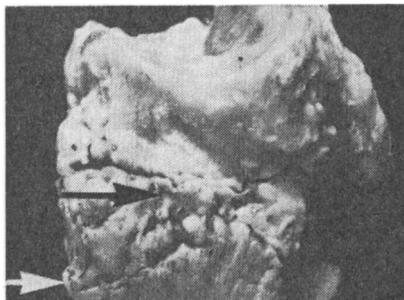


Figure 12. Osteophyte formations (arrows) on the mediolateral tarsal bones and the metatarsus of a 2 years old sow.

lage cells towards the surface were desquamated, and there were sometimes collections of "brood capsules". Histological examination of the degenerated intervertebral discs and vertebral bodies showed that degenerated, often necrotic, masses commonly penetrated into the epiphyseal plate and the vertebral body. In the bone tissue there was evidence of marked bone resorption, necrosis and abundant connective tissue. In some cases, there was a quite pronounced infiltration of inflammatory cells. The epiphyseal plate could be very irregular, also in cases without a marked degeneration of the disc.

#### DISCUSSION AND CONCLUSIONS

This investigation shows that osteochondrosis, a condition which occurs frequently in young pigs (*Grøndalen* 1974), also occurs at the same sites in joints and bones in young breeding animals. In animals more than 1—1½ years old, osteochondrosis is less common, or has undergone repair. Therefore, it seems that osteochondrosis is most widespread around the time at which sexual maturity is reached, and that lesions which do not affect the surface of the joint cartilage can heal completely or undergo repair when the most active period of growth is over. Lesions which affect the superficial part of the joint cartilage in the form of cracks and separations will, as a rule, continue developing as a progressive arthrosis. Although it may seem somewhat strange to differentiate between arthrosis and osteochondrosis, it is felt that both these diagnoses should be applied. It was decided to apply the diagnosis osteochondrosis to local, primarily non-inflammatory disturbances in the endochondral ossification process in the epiphyseal plates and in joint cartilage with no superficial cartilage lesions. The term arthrosis is used when degenerative or proliferative primarily non-inflammatory lesions occur in the surface or in the surface and the deep layer of the joint cartilage (*Grøndalen*). Arthrosis has a complex aetiology (*Olsson* 1971), and is assumed to be most widespread in older animals (*Jubb & Kennedy* 1970). The lesions of severe degree in the stifle joint did not follow this pattern. In material I, they were, with 1 exception, confined to animals less than 1 year old. This lesion probably causes such severe locomotory problems that the animal is slaughtered relatively quickly. The medial condyle of the femur seems to be more resistant as regards severe lesions after the period of most active growth is over. These factors probably

explain why severe lesions are seldom demonstrated in animals more than 1½ years old. Severe degree arthrosis was frequently demonstrated in the elbow joint, most commonly as a further progression of an osteochondrosis, and was found in all groups. Therefore it seems that arthrosis of the elbow joint did not create as great a handicap to the pig as arthrosis of the stifle joint.

Epiphyseal separation of the head of the femur was demonstrated in animals less than 1 year old. This condition is, as osteochondrosis, a problem of young breeding animals. Epiphyseal separation also occurred in other bones, 1 animal showing the condition in a lumbar vertebral body. Separation of the tuber ischii as described in the sow by *Pettersson & Reiland* (1967) was demonstrated unilaterally in 3 sows and 1 boar. Repair had taken place and indicates that the animal is not always handicapped in such a way that it is killed immediately.

It is conceivable that epiphyseal separation is the result of mechanical injury and overloading of an epiphyseal plate already weakened by patho-anatomical changes (*Herrmann* 1969). In man, epiphyseolysis occurs at a stage of rapid growth around puberty, often in patients with delayed closure of the epiphyseal plates and a tendency to obesity (*Sørensen* 1968). According to *Harris* (1950) it seems to be predisposed by an excess of growth hormone. *Razzano et al.* (1972), however, found no abnormalities of serum growth hormone or oestrogen levels in 5 patients studied with slipped capital femoral epiphysis. *Duthie & Lancaster* (1964) have demonstrated necrosis of the growth plate cartilage and adjacent bone in pigs, and they connect this with epiphyseal separation. *Thurley* (1969) also considers that degenerative processes in the epiphyseal plate may be a contributory factor in separation. Abnormalities and degenerative processes in the epiphyseal plate of the head of the femur were demonstrated relatively often by *Grøndalen*, and support the conclusions of *Herrmann*, *Duthie & Lancaster* and *Thurley*. Furthermore, it seems logical that overloading can lead to epiphyseal separation as well as to bone fractures. The described low head of the femur, in which the teres ligament as well as the joint cartilage were intact, also seems to be due to abnormalities of the epiphyseal plate, resulting in premature closure and reduced lengthwise growth. Cases where a low femoral head showed arthrotic changes seem to be the same condition as described by *Christensen* (1953). This was the most constantly found lesion in his material.

An area of wear cranioventrally on the edge of the acetabulum was demonstrated in 3 boars. In these cases there was rupture of the teres ligament. This wear surface must have been caused by a repeated subluxation of the femoral head. This is an unusual direction for luxation, but could have occurred during copulation, due to a dysplastic acetabulum, faulty positioning of the neck and head of the femur, or altered lever action and direction of muscle pull, together with the enhanced movement made possibly by the rupture of the teres ligament. Otherwise it is difficult to say what is the primary factors in this condition. There were also areas of wear due to habitual subluxation in the shoulder joint. While occurring both in the sow and boar, such lesions were most common in older boars. This is possibly due to the extra load put onto the forelegs when gripping the sow or sow-phantom.

Arthrosis of the tarsal joint was much more pronounced in older animals than in young ones. Incidence was high, and changes were, at times, severe. *Sabec et al.* (1961), among others, have described the same in Germany and ascribed a certain significance to it in the leg weakness complex. Norwegian breeding pigs have severe lesions in joints with more mobile bones, and the changes in the hock joint can therefore perhaps be considered to be of minor significance. Minor significance has also the worn-down cartilage on the medial condyle of the femur in older animals. This lesion seemed to be purely the result of contact with the medial part of the tibial intercondyloid eminence.

Patho-anatomical changes in the vertebral column seem to be of major significance in Norwegian breeding pigs. A large proportion of the animals had severe degree degenerated intervertebral discs, spondylosis and arthrosis, sometimes with joint mice and chip fractures in the lumbar intervertebral joints. There was a higher incidence of intervertebral joint lesions, as regards the investigated materials, in boars than in sows. These changes have been previously demonstrated in Norwegian slaughter pigs (*Grøndalen*). In Sweden, *Hansen & Reiland* (1968) have also demonstrated lesions in the intervertebral joints of pigs. Otherwise, changes in the vertebral column of the same degree and incidence as those recorded in relatively young animals in Norway, have not been reported from other countries. *Brown & Johnson* (1970) demonstrated vertebral exostoses and intervertebral ankyloses in 46 % of pigs more than 7 years old. *Kurzweg*

& Winkler (1972) mentioned a diagnosis of ankylosing spondylarthritis in 2 boars, but did not give details as to how many animals were investigated. In the present study there was a markedly higher incidence of degeneration of intervertebral discs and spondylosis in the sow material than in the boar material. Grabell *et al.* (1962) demonstrated that swine erysipelas bacteriae easily invade intervertebral discs, causing degeneration, and one can thus expect herd differences, even though the slaughterhouse material also showed a higher incidence in sows. Spiegel *et al.* (1972) assume that disc space inflammation in children has an infectious aetiology, even though it is often impossible to demonstrate any agent. Although bacteriological examination of 7 cases of degenerated nuclei pulposi was negative, it is felt that an infectious aetiology cannot be ruled out. Otherwise it seems conceivable that degeneration of intervertebral discs at such a young age in non-chondrodystrophic animals could be due to special conditions regarding the load put onto the discs and their nutrition. The main difference in the load stress on the back of a sow as compared with that of a boar, is probably that a pregnant sow is very prone to develop a concavely bowed back, while the boar, during mating, must bend its back convexly to the fullest possible extent, especially the lumbar region. The damaged epiphyseal plates of the vertebral bodies could have been primarily affected or affected by changes in the discs. In material IV (sows) vertebral column lesions were concentrated in 2 main areas, from the last thoracic to the second lumbar vertebrae, and at the junction between the last lumbar and first sacral vertebrae. The reason for these localizations is unknown. Spondylosis occurred most commonly on the lateral aspect of the vertebral bodies. A possible explanation for this could be that the swaying gait, often seen in Norwegian pigs, leads to abnormal stress on the lateral parts of the vertebral epiphyses. There was otherwise a strong relationship between degeneration of nuclei pulposi and spondylosis. Hansen (1952) has previously discussed the relationship between these in the dog.

Arthritis was of minor significance in the pigs which were the subject of the present investigation, though it may certainly be of greater significance under other conditions. Fibrous thickening of the capsule and villous proliferations in the synovial layer were not uncommon, but usually appeared to be secondary to other lesions in the joint. Acute injuries with haemorrhages

in the capsule and ligaments which were frequently demonstrated in slaughter pigs (*Grøndalen*) were less common in older animals. This might indicate that the ligamental apparatus of grown up animals is more resistant against overloading than in the young animals.

#### ACKNOWLEDGEMENTS

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#### SAMMENDRAG

##### *Osteochondrose og arthrose hos gris. II. Forekomst hos avlsdyr.*

Ledd- og skjeletlesjoner hos norske avlsgriser er beskrevet etter undersøkelse av 174 purker og 155 råner fra 7 mndr til 4½ år gamle. Lesjonene, som vesentlig besto av arthrose, degenerasjon av intervertebralskiver, spondylose og epifyseløsninger, ble hyppig påvist hos begge kjønn. Osteochondrose, som en tidligere hyppig har påvist hos slaktegriser, var enten helet, reparert eller utviklet til en arthrose når dyra var blitt omkring 1½ år gamle. Arthrose i intervertebral-ledda ble oftere påvist hos råner enn hos purker, mens det var omvendt med hensyn til degenererte intervertebralskiver og spondylose. Mulige årsaker til dette er diskutert. Norske griser hadde en høyere forekomst av lesjoner i lumbaldelen av ryggen enn til nå beskrevet fra andre land.

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