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Osteochondrosis of the elbow joint in finishing pigs from three herds: Associations among different types of joint changes and between osteochondrosis and growth rate ☆

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ABSTRACT

Osteochondrosis (OC) is a degenerative condition of the cartilage seen in growing animals. The objective of the study was to investigate (1) the prevalence of macroscopically visible OC in the elbow of finishing pigs, (2) the relationship between changes in the surface of the articular cartilage and changes in the underlying cartilage and bone and the synovial membrane, and (3) the association between growth rate and the occurrence of OC in the elbow. The study used 9696 finishing pigs from three herds. After slaughter, the left elbow joint of each pig was examined, and macroscopically visible lesions in the articular cartilage, subchondral bone and synovial membrane were recorded.

The highest prevalences of OC lesions were found in the humeral condyle with thickening of the articular cartilage (53%), irregularity of the articular cartilage (32%), lesions in the subchondral bone (26%), fissures under the cartilage (21%) and osteochondrosis dissecans (OCD) (14%). Irregularity of the articular cartilage was strongly associated with fissures under the cartilage and lesions in the subchondral bone (OR 13.7 and 5.8, respectively). Irregularity of the articular cartilage and OCD were associated with villous proliferation of the synovial membrane. For each additional 100 g of average daily gain in the weaner period or in the finishing period, the risk of irregularity in the articular cartilage and OCD increased by approximately 20% (ORs ranging between 1.14 and 1.20 for both weaners and finishers).

Introduction

Osteochondrosis (OC) is a non-infectious, degenerative condition of the articular–epiphyseal cartilage and growth plate with secondary changes in the bone (Ytrehus et al., 2004). OC is seen in growing animals, and macroscopically visible lesions are typically found in joints with OC, namely, local thickening of articular cartilage, irregular cartilage surfaces, fissures between cartilage and subchondral bone, osteochondrosis dissecans (OCD) and necrosis of subchondral bone (Reiland, 1978).

Genetic factors, growth rate, lean meat percentage and mechanical stress are all thought to play a role in the development of OC (Nakano and Aherne, 1988; Stern et al., 1995; Kadarmideen et al., 2004). However, studies of the association between growth rate and OC have shown contradictory results (Lundeheim, 1987; Carlson et al., 1988; Stern et al., 1995; Ytrehus et al., 2004).

Irregular cartilage surfaces and OCD are visible on the surface of the articular cartilage and are therefore easy to diagnose in the slaughtered animal. In contrast, thickening of articular cartilage, fissures between cartilage and subchondral bone and necrosis of subchondral bone can be seen only when the cartilage and bone have been cut through with a saw. As a result, it is appropriate to investigate how closely the two groups of lesions are associated and how much extra information is obtained by carrying out the time-consuming procedure of cutting through cartilage and bone.

It must be assumed that lesions in the surface of the articular cartilage can lead to some degree of inflammation in the joint, and mild proliferation of the synovial villi in joints with OC has been described (Johnston et al., 1987). However, the association between OC and macroscopically visible signs of joint inflammation has not yet been quantified.

The objective of the present study was to investigate (1) the prevalence of macroscopically visible OC in the elbow of finishing pigs, (2) the relationship between changes in the surface of the articular cartilage and changes in the underlying cartilage and bone and the synovial membrane, and (3) the association between

☆ Part of this work was presented at the 19th IPVS Congress and some of the preliminary findings have been published (Busch et al., 2006a,b, 2007).

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growth rate and the occurrence of OC in the elbow. Other results based on the same study have previously been published in two papers focusing on genetic analysis and quantitative trait loci (QTL) analysis of OC (Jørgensen and Nielsen, 2005; Christensen et al., 2010).

Materials and methods

Study herds and animals

The study used pigs born in three commercial farrow-to-finish herds over a period of approximately 14 months in 2000–2001. The prevalence of lameness or OC in the herds was not known when the herds were selected, and information about the history of lameness in the herds was not obtained. The three herds were originally chosen for an investigation into enzootic pneumonia. Information about the production conditions in the study herds is shown in Table 1.

The pigs were individually ear-tagged at birth. The extent of cross-fostering was limited, and pigs that were moved to another sow were excluded from the study. The pigs were weaned at approximately 4 weeks of age and were transferred to weaner units. At approximately 12 weeks of age, the pigs were transferred to finishing units. Litter mates were kept together in both the weaner units and the finishing units, though each pen would contain several litters. Pigs that were moved to hospital pens at any time during the study were excluded.

A total of 9696 pigs from 1092 litters were included in the final dataset. All pigs were crossbreeds of Danish Landrace/Yorkshire sows and Duroc boars (699 sows, 14 boars). Progeny from all 14 boars were born in all sow herds. The pigs were weighed individually at birth, at weaning and at transfer from the weaner unit to the finishing unit. Liveweight at slaughter was estimated as the carcass weight multiplied by 1.31 (Kjeldsen and Pedersen, 1990). Based on the weights, the average daily gain (ADG) was calculated for each pig for the following periods: the suckling period, the weaner period (from weaning to transfer to the finishing unit) and the finishing period. In addition, the ADG from birth to slaughter was calculated. Litter mates were always slaughtered on the same day.

Recording of joint lesions

The elbow joints were examined at the slaughterhouse on the day after slaughter. It was decided to include only the left elbow joint as OC lesions are usually bilaterally symmetrical (Reiland, 1978). Each left elbow joint was examined macroscopically by one of three investigators (all veterinarians). First, abnormalities in the synovial membrane and the surface of the articular cartilage were recorded. The humeral condyle was then cross-sectioned with a band saw, and further recordings were made. The cut was perpendicular to the surface of the cartilage and to the axis of the joint (Fig. 1D). Abnormalities in cartilage and bone were recorded according to Jørgensen et al. (1995). The study did not include examination of growth plates.

The variables describing the findings in cartilage and bone are shown in Table 2. For irregular joint surfaces, a score of 1–4 represented increasing severity of irregularity/invagination of the cartilage, whereas score 5 was used for OCD only. The remaining types of lesions were scored on a scale from 1 (normal) to 5 (severe lesion) or as presence/absence traits (1, absent; 2, present). Examples of some types of lesions are shown in Fig. 1.

Statistical analysis

All statistical analyses were performed using SAS software version 9.2. Associations between lesions in the articular surface and lesions in the underlying cartilage and bone were described by odds ratios (OR), assuming either the presence or absence of the condition. The probability of villous proliferation, as dependent on the status of the articular surface (irregularity scores 1–4 or OCD), was modelled by a logistic regression model (SAS LOGISTIC procedure) including herd and investigator as explanatory variables. The same model was used to assess the effect of defects of the cartilage surface of the radius and/or ulna on villous proliferation.

The association between the occurrence of a lesion in the cartilage surface and suspected predictors was described by a logistic regression model (SAS GLIMMIX procedure). Predictors included ADG (suckling period, weaner period and finishing period), time trend, season (four quarters), herd (4), gender (2), investigator (3), birth weight and the following random effects: boar, sow, litter and room. The effects of the systematic factors were expressed as ORs, with the value 1 corresponding to 'no effect'. An OR could be perceived as a relative risk. Thus an OR of 1.20 would imply a relative surplus risk of 20% compared to a reference. The relative importance of each random effect was derived as a percentage of the total random variation, summing to 100%. In a separate model, total ADG (from birth to slaughter) was substituted for the three period-specific ADGs to obtain an overall ADG effect. No formal variable selection was performed in this analysis, since all explanatory variables were regarded as plausible a priori. The effects of time trend, season, herd and investigator were however entirely relative to the conditions of the present study, and estimates are therefore not reported in the results. The pairwise correlations between the three period-specific ADGs were all below 0.35, and it was therefore considered reasonable to include them simultaneously in the analysis.

Results

Prevalences of lesions

Table 3 shows the prevalence of the recorded lesions. No substantial differences between herds were found, and only the overall results for all study herds are shown. Thickened cartilage and irregular cartilage surface were the most common findings, and lesions were generally more prevalent in the medial part of the humeral condyle than in the lateral part. In 35.0% of the joints, no lesions were found in cartilage or bone, and in 29.6% thickening of the cartilage was the only lesion found in cartilage or bone. Villous proliferation and bloody synovia were the most common abnormalities seen in the synovia or synovial membrane. Table 4 shows the prevalence of joints with the different types of lesions in the humeral condyle without any distinction between the lateral and the medial part of the humeral condyle. In the case of several abnormalities of the same type in a condyle, only the severest abnormality was considered. OCD was found in 13.7% of the joints.

Table 1
Production conditions in the study herds and the number of pigs in the study.

	Herd			
	A	B	C – site 1	C – site 2[a]
Number of sows in the herd	300	205	340	0
Farrowing units				
Flooring	Partially and fully slatted	Partially slatted	Fully slatted	–
Weaner units				
Time in weaner units	8 weeks[b]	8 weeks	8 weeks	–
Flooring	Partially slatted	Fully slatted	Partially slatted	–
Finishing units				
Flooring	Fully slatted	Fully slatted	Fully slatted	Fully slatted and solid
Feed	Liquid home-mixed	Liquid home-mixed	Liquid home-mixed	Pelleted dry purchased
Feeding strategy	Moderately restrictive	Moderately restrictive	Moderately restrictive	Ad libitum
Number of study pigs	3076	2757	2835	1028

[a] Site 2 of herd C was a finishing site receiving pigs from the weaner units on site 1.
[b] In herd A, the pigs spent the last 4 weeks of the 8-week period in a growing unit with fully slatted floors.