The Interaction of Osteochondropathy, Reduced Dietary Phosphorus Level and Mycoplasma Hyosynoviae in the Onset of Lameness in Fattening Pigs: A Case Report

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Case report

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Abstract

Background

Various diagnostic procedures, their results and interpretation in a case with severe lameness in fattening pigs are described. It is shown, that selected diagnostic steps lead to identification of the key factors for disease development in the respective herd. One focus is the assessment of the impact of reduced dietary phosphorus level on disease development.

Case presentation

In a farrow-to-fattening farm lameness occurred in pigs with 40-70 kg body weight. Necropsy of three diseased pigs revealed claw lesions and alterations at the knee and elbow joints. Histological findings were characteristic for osteochondropathia. All pigs were positively tested for *Mycoplasma hyosynoviae* in affected joints. In addition, analysis of diet composition revealed a low phosphorus content in two diets, which might had led to insufficient supply in individuals with high average daily gains with respect to development of bone mass and connective tissue. The impact of dietary factors for disease development could not be verified in the selected animals by blood analysis and bone ashings in this case. Finally, change in feed and antibiotic treatment of individual animals led to improvement of clinical symptoms.

Conclusions

*Mycoplasma hyosynoviae* was identified to be an important aetiological factor for disease. Other, non-infectious factors, as osteochondrosis and claw lesions might have triggered development of disease. A calculated marginal phosphor supply for pigs with high growth rates in a limited time period might further had weakened cartilage and connective tissue, and facilitated adherence of infectious agents in joints. Diagnostic of insufficient phosphorus supply by blood analysis and bone ashing might be not successful, when it occurs temporarily in time periods prior to sampling.

Background

*Mycoplasma (M.) hyosynoviae* is a commensal of the upper respiratory tract, especially in the tonsils [1] that may lead to clinical disease mainly in older pigs (> 10 weeks) [2] The detection rate has increased in the last years [2, 3]. Affected pigs show avoidance of rising up or an impaired ability to stand within approximately 24 hours post infection [4, 5]. The clinical symptoms include sudden lameness affecting one or more limbs with balancing weight from one leg to the other [5] up to the dog sitting position [6]. Young adults often experience 2–3 lameness periods over a 4–6 week period [7]. *M. hyosynoviae* is probably present in many herds worldwide, high morbidity rates occur in fattening pigs between 50–60 kg, but gilts and breeding boars could be affected as well [1]. It is also known that joint infections with *M. hyosynoviae* can be clinically asymptomatic, since the pathogen has also been diagnosed in synovial
fluid of non-lame pigs [8]. For this reason, additional trigger factors for disease development should be taken into account during the diagnostic procedure.

In recent years, the German fertilization ordinance (Düngeverordnung, DÜV) [9] law has been continuously developed with the aim to reduce the nitrogen and phosphorous load of the environment. Both elements lead to eutrophication in surface waters of lakes and streams [10]. As nitrate was found in places in German ground water in high levels beyond the tolerable threshold for quality standard of 50 mg/l [11] several restrictions in manuring came in force to reduce emissions from intensive animal production. As P is concentrated in pig and poultry manure, concerns about P emissions are high in pig and poultry production as well [12]. In the period from 2012 to 2014, agriculture accounted for 50% of P inputs and about 75% of N inputs into German surface waters [11]. Based on these findings, efforts are being made to minimise nutrient surplus in plant and animal production. The reduction of P and N is regulated in both, national and international legislation [9, 13, 14]. A high potential measure for emission reduction is a N- and P-reduced feeding concept adapted strictly to the animal’s requirements [15]. Varying dietary nutrient levels in feed result from different growth and weather conditions and can hardly been estimated, so that any requirement calculations based onto reference standard concentrations for animal feedstuff bear the risk of a marginal nutrient supply. A specific problem is the correct estimation of digestible P, which cannot be defined in routine testings and can vary between different crobs [16]. P utilization is not only dependent on the form of the P sources used (inorganic vs. organic) but also on the activity of phytases present in the diet (endogenous or added) and the Ca:P ratio [17]. Microbially produced phytases are routinely added to swine diets, whereby the proportion of digestible P can be increased within the total P content [17]. As a consequence of the tightening of law various measures are taken by farmers to reduce emissions and especially the introduction of P and N to the environment. P in particular is frequently reduced in the diet of pigs to reduce P content in manure and to save costs of this expensive resource. However, reduced dietary P levels in the weaner-grower period can lead to impaired bone mineralisation [18]. It should also be noted that bone mineralisation in the early growth phase of mammals is fundamental for maximum bone mineralisation in later life and is therefore crucial for prevention of locomotory disorders [19].

**Case Presentation**

In a farrow-to-finishing farm with 500 sows and 5000 fattening pigs in North Rhine-Westphalia, Germany, lameness occurred in non-castrated male and female fattening pigs with 40–70 kg body weight. The genetic background in sows was Danbred, while the piglets were crossbreeds of Danbread x PIC 408. After a suckling period of 4 weeks, piglets were raised in groups of 42 animals per pen up to a weight of 35 kg in the nursery unit on plastic slatted floor until week twelve of age. In total, nursery has 3000 places with 860 pigs in one separate unit. In the fattening stable with 5000 places in total, 700 pigs were kept in one unit with 35 pigs per pen. In the fattening stable with 5000 places in total, 700 pigs were kept in one unit with 35 pigs per pen. Average daily weight gain was 820 g in fatteners within an average fattening period of 110 days. Within one year, 3.3 fattening periods were fulfilled on this farm. Feed samples were sent to the LUFA/Chamber of Agriculture North Rhine-Westphalia for analysis of nutrient contents. Total protein content was high, while crude fibre content was low (Table 1).
### Table 1
Diet composition and feeding techniques

|                         | Diet for growing pigs (AZ-3) (88% DM) | Diet for fattening pigs 1 (VM28) (88% DM) | Diet for fattening pigs 2 (AM40) (88% DM) | Diet for fattening pigs 3 (MM 65) (88% DM) |
|-------------------------|---------------------------------------|-------------------------------------------|------------------------------------------|------------------------------------------|
| Crude protein (%)       | 18.1                                  | 18.2                                      | 16.8                                     | 17.4                                     |
| Crude fibre (%)         | 3.0                                   | 2.9                                       | 3.5                                      | 3.8                                      |
| Ca (g/kg)               | 9.2                                   | 8.1                                       | 8.7                                      | 7.9                                      |
| P (g/kg)                | 4.6                                   | 4.6                                       | 4.6                                      | 4.9                                      |
| Feeding techniques      | 42 pigs in one pen, 84 pigs at one feeding valve, length of feeding trough 2.5 m | 35 pigs in one pen, 70 pigs at one feeding valve, length of feeding trough 3.8 m |

Analysed values of diet composition and feeding techniques in the different age groups are shown. Content of P is highlighted in bold, if it is assessed to be critically low compared with the calculated demand in Table 2.

Recommendations for Ca- and P-requirements according to weight and growth rate are shown in Table 2. Phosphorus content was reduced in the diet, but fermentation of feed for the nursery and fattening pigs aimed to increase the phosphorus digestibility. Origin of drinking water was self-sufficient supplied well water.
### Table 2
Recommendations and assessment of P supply

| Daily intake of Ca (g) | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 120 |
|-----------------------|----|----|----|----|----|----|----|-----|-----|
| Body weight (kg)      |    |    |    |    |    |    |    |    |     |
| Average daily weight gain (g) |     |     |     |     |     |     |     |     |     |
| 700                   | 9.1| 9.3| 9.6| 9.9| 10.2| 10.5| 10.5| 10.7| 11.0|
| 800                   | 10.3* | 10.6| 10.8| 11.1| 11.4| 11.7| 11.7| 11.8| 12.1|
| 900                   | -  | 11.9| 12.0| 12.4| 12.6| 12.9| 12.9| 12.9| 13.2|
| 1000                  | -  | 12.0*a | 13.2 | 13.7*a | 13.9 | 14.1 | 14.1 | 14.0 | - |
| 1100                  | -  | -  | -  | 15.0 | 15.3 | 15.4 | 15.4 | -  | -  |

| Daily intake of digestible P (g), approx. 60% of total P | 700 | 800 | 900 | 1000 | 1100 |
|----------------------------------------------------------|----|----|----|------|------|
| Feed (88% DM) intake (kg)                                | 1.1| 1.6*a| 2.0| 2.1*a| 2.3 |

| Assessment of P supply on farm | 9,2 | 9,8 | 10 |
|-------------------------------|-----|-----|----|
| Re-calculated required amount of P (g) per pig and day in respective age group with 1000 g average daily gain | 5,72 | 4,68 | 3,8 |
| Calculated required total P (g) per kg diet (88%DM) |     |     |    |

Calcium and phosphorus requirements of fattening pigs in dependence of body weight and daily gain according to Standards of the Society of Nutrition Physiology 2008 [35] in comparison to the calculated supply (feed intake multiplied by analysed mineral content). In pigs with 30 or 50 kg body weight and high average daily gain (1000 g) a marginal supply with diets for growing (AZ-3) and fattening (VM28) pigs can be assumed as shown in Table 1 (critical values are shown in bold). * Values depicted by stars are not recorded within the original tables of the recommendations for the supply of energy and nutrients to pigs [35], but were linear extrapolated by the authors.
### Daily intake of Ca (g)

| a values were used for calculation of supply in the example |

All pigs were vaccinated with commercial vaccines against the Porcine Reproductive and Respiratory Syndrome virus, Porcine Circovirus 2 and *M. hyopneumoniae* at an age of 24 days, i.e. prior to weaning. At an age of 50 and 70 days pigs were vaccinated against *Actinobacillus pleuropneumoniae*.

Clinical examination resulted in high-grade lameness with a stiff walk in approximately 10–35% of the fattening pigs at an age of 80–140 days (30–70 kg body weight (bw)). Limbs were free from swellings and no obvious signs for arthritis were observed. For treatment of pigs with lameness amoxicillin trihydrate (Hostamox LA 150 mg/ml, MSD, Unterschleißheim, Germany, 15 mg/kg bw) was injected 2–4 times at 24 h intervals. In addition, 0.1 mg dexamethasone per kg bw (Rapidexon Albrecht, Dechra Veterinary Products Deutschland GmbH, Aulendorf, Germany) was injected at 1–2 days. Approximately 90% of the treated pigs recovered within one week after treatment. The oral treatment with 10 mg tiamulin fumarate (Denagard 45%, Elanco Deutschland GmbH, Bad Homburg, Germany) per kg bw given in feed was not successful.

In February 2019, three untreated pigs showing severe lameness were submitted to the Field Station for Epidemiology of the University of Veterinary Medicine Hannover in Bakum for diagnostics. After clinical examination of pigs and before transport to the diagnostic unit, the herd attending veterinarian performed X-raying of painful limbs under deep anaesthesia after intramuscular administration of 2 mg azaperone/kg bw (Stresnil®, Elanco Deutschland GmbH, Bad Homburg, Germany) and 20 mg ketamine/kg bw (Ursotamin®, Serumwerk Bernburg, Bernburg, Germany). Digital x-ray examination of the joints was performed in a radiological unit (Vetsystem 30, IBM, Armonk, NY, USA) with automatic exposure with the following pre-settings: 30 kW, 40–125 kV, 25–400 mA, 0.1–315 mAS. Anaesthetized animals were placed in lateral or sternal recumbency depending on path of rays. Not all joints were X-rayed in all pigs. Slight irregularities were found in the epiphyseal transition zone at the knees of pig 2 and pig 3 (Fig. 1) as well as the elbow joints in pig 1. No other joints showed pathological findings in X-ray pictures.

After euthanasia pigs were necropsied. Macroscopic findings are summarized in Table 3. Main macroscopic findings were claw lesions and thickened joint tissue, thus subsequent diagnostic steps were initiated. Macroscopic cartilage lesions are shown in Fig. 2 and claw lesions in Fig. 3. While by cultural microbiological testing of articular swabs no pathogens were detectable, real-time PCR was positive for *M. hyosynoviae* (cycle threshold (ct) value 29–32) in all three animals.
Table 3
Macroscopical findings regarding joints, limbs and claws of the three pigs

| Pig 1          | Pig 2          | Pig 3          |
|----------------|----------------|----------------|
|                | (female, 45 kg)| (male, 32 kg)  | (female, 39 kg) |
| joints         |                |                |                |
| elbow and tarsal joint: | slight increase in synovia, turbid synovia, redness of synovialis | carpal joint: | carpal joint: |
| joint tissue | surrounding joint tissue | slightly increase in synovia, turbid synovia, redness of synovialis | slightly increase in synovia, turbid synovia, redness of synovialis |
| knee joint     |                |                |                |
|                | slightly increase in synovia, turbid synovia |                |                |
| carpal joint   |                |                |                |
|                | slight increase in synovia, turbid synovia |                |                |
| tarsal joint   |                |                |                |
|                | surrounding joint tissue | slightly increase in synovia, turbid synovia | surrounding joint tissue |
|                | thickened      |                | thickened      |
| Limbs          |                |                |                |
| left hindlimb: | coronary band of lateral claw: | 1 × 1 cm large wound | all limbs: |
|                |                |                | multifocal small wounds |
| Claws          |                |                |                |
| dew claws:     |                |                |                |
| medial claw, 2 × 1 cm lesion at the lateral wall, skin of the coronary band not intact | left forelimb, lateral claw: | upper sole layer of the lateral claw removed, lower layers appear dark and rough | lateral claws of the forelimbs: |
|                |                |                | wall horn fissures in the caudal parts |
| all claws:     |                |                |                |
| horn detachment |                |                |                |

Histological examinations of the stifle joints were performed at the Department of Pathology at the University of Veterinary Medicine Hannover resulting in inflammatory as well as degenerative lesions (Fig. 4, Table 4).
Table 4
Histological findings in stifle joints

|                  | Pig 1 (female, 45 kg)          | Pig 2 (male, 32 kg)                      | Pig 3 (female, 39 kg)                      |
|------------------|--------------------------------|-----------------------------------------|-----------------------------------------|
| Femur, articular | Multifocal pannus formation with demasking of collagen fibers | Multifocal cartilage cones, multifocal chondrocyte degeneration and eosinophilic streaks | Multifocal cartilage cones, multifocal chondrocyte degeneration, mild medullary fibrosis |
| epiphyseal       |                                |                                         |                                         |
| cartilage        |                                |                                         |                                         |
| Femur, physis    | Single cartilage cones         | Multifocal cartilage cones, multifocal chondrocyte degeneration and eosinophilic streaks | Multifocal cartilage cones, multifocal chondrocyte degeneration, mild medullary fibrosis |
| Stifle joint,    |                                |                                         |                                         |
| synovial         | Mild to moderate, multifocal to coalescent, lympho-plasmahistiocytic synovialitis | Moderate, fibrinosuppurative, partly lympho-plasma-histiocytic synovialitis | Mild to moderate, multifocal, lympho-plasma-histiocytic synovialitis |
| membrane         |                                |                                         |                                         |
|                  |                                |                                         |                                         |

In addition, one femur of each of the three pigs was ashed in the Institute of Animal Nutrition and serum samples were sent to the Clinic for Swine, Small Ruminants and Forensic Medicine of the University of Veterinary Medicine Hannover to determine the concentration of calcium and phosphorus (Table 5).

Table 5
Results of blood analyses and femoral ashing of the three pigs

|                  | Reference values | Pig 1 (female, 45 kg) | Pig 2 (male, 32 kg) | Pig 3 (female, 39 kg) |
|------------------|-------------------|-----------------------|---------------------|-----------------------|
| blood analyses   |                   |                       |                     |                       |
| AP [U/l]         | 90–200            | [34]                  | 257                 | 175                   | 186                   |
| Ca [mmol/l]      | 2.4–3.0           |                       | 2.86                | 2.53                  | 2.56                  |
| P [mmol/l]       | 1.3–3.3           |                       | 2.96                | 2.69                  | 2.79                  |
| haemoglobin      | -                 |                       | 0.27                | 0.4                   | 0.35                  |
| femoral ashing   |                   |                       |                     |                       |
| DM [g/kg]        | -                 | [25]                  | 473                 | 379                   | 422                   |
| Ash [g/kg ffr DM]* | 493 ± 20.4       |                       | 486                 | 438                   | 475                   |
| Ca [g/kg ffr DM]* | 154 ± 8.7        |                       | 180                 | 159                   | 177                   |
| P [g/kg ffr DM]* | 79.3 ± 3.43      |                       | 83                  | 75.1                  | 83.5                  |

* gram per kilogram fat-free dry matter, AP alkaline phosphatase
Neither the chemical bone analyses nor blood concentrations of calcium and phosphorus gave evidence of mineral deficiency in the animals, if data were compared with reference values or data from experimental studies (Table 6).

Table 6
Blood phosphorus concentrations of growing pigs [25]

| Days on dietary treatment | Body mass | Blood P (mmol/l) feeding diet with inorganic P and with phytase | Blood P (mmol/l) feeding diet without inorganic P but with phytase | Blood P (mmol/l) feeding diet without inorganic P and without phytase |
|--------------------------|-----------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| 26                       | 55        | 2.65 ± 0.15                                                   | 1.62 ± 0.27                                                   | 1.58 ± 0.15                                                   |
| 47                       | 70        | 2.38 ± 0.42                                                   | 1.65 ± 0.11                                                   | 1.32 ± 0.33                                                   |
| 82                       | 100       | 2.21 ± 0.37                                                   | 1.73 ± 0.07                                                   | 1.35 ± 0.51                                                   |

Blood phosphorus concentrations (mmol/l) of growing pigs fed different experimental diets with respect to mineral P content and phytase [25].

A serum pool sample of the pigs was also sent to GD (Gezondheidsdienst voor Dieren, Deventer, the Netherlands) to determine bone markers osteocalcine and C-telopeptid (CTx) reflecting bone metabolism. Osteocalcine is indicative for bone formation, while CTx marks bone resorption. While osteocalcine-concentration was reduced (20.0 µg/l [reference value: >50 µg/l]), CTx was within the reference range (0.17 µg/l [reference value: <0.2 µg/l]). As a consequence the osteocalcine:CTx ratio (osteocalcine:CTx = 117.6 [reference range: >150]) was reduced.

**Interpretation of findings and measures**

Diagnostic findings indicated towards a multifactorial disease pathogenesis.

Clinical findings were typical for both, arthritis caused by *M. hyosynoviae* and osteochondropathia. Histological findings reflected degenerative cartilage and bone alterations characteristic for osteochondrosis (OC). Bone markers indicated towards an inadequate mineralization. In addition, all pigs were infected by *M. hyosynoviae*.

Clinical findings of a progressive, shifting lameness, which affects one or more limbs, reluctance to move or to stand up, changing posture of the hind legs were typical for the disease. In addition, severe claw lesions were found, which could be in addition a trigger factor for disease due to disturbed body weight balancing, or which could be the consequence from focussed increased forces onto the claws due to specific postures. Feed AZ3, VM28, AM 40 were changed towards a feed with higher P content. Individual pigs were treated with antibiotics as mentioned above (amoxicillin). Within four months the incidence of diseases decreased to less than 5%.

**Discussion And Conclusions**
All findings in fatteners with impaired moving activity in this farm led to the assumption, that *M. hyosynoviae* as an infectious factor was involved in disease pathogenesis in combination with osteochondropathy. Since degenerative joint diseases, such as OC, are important predisposing factors in *M. hyosynoviae* disease [20], other aetiological cartilage pre-damages might also contribute to the adhesion of *M. hyosynoviae*. In puppies the negative impact of an undersupply with P onto the musculoskeletal system has been described. Affected puppies showed a loss of muscle strength, deviation of the limb axis and hyperflexion of joints, indicating the demand of P also for the connective tissue [21]. Several studies have shown that P-reduced feeding can cause degenerative but also other pathological skeleton alterations. It is known, that embedding of bone mineral elements in later life in mammals depends on the supply in the early stages of growth and bone development [19]. During skeletal development growth cartilage in the plate of the physis is responsible for longitudinal growth, while the articular–epiphyseal cartilage is shaping the long bone ends. Within a sequential progress including matrix mineralization enchondral ossification is achieved by parallel continuous production of cartilage and its replacement by bone [22]. The rate and direction of growth is assumed to be affected also by nutritional and metabolic factors [22].

In this case the result of bone marker determination hinted at a potential insufficient mineral supply. Serum osteocalcine has been found to be a more accurate indicator of bone mineralization in pigs than alkaline phosphatase in serum [23]. Disadvantages are that osteocalcine is relatively unstable and serum samples should therefore be processed and frozen within one hour after collection. Suppressive effects might occur, when the animal is pretreated with corticosteroids [24]. Results from the one pooled sample analysed in this study might suggest, that bone formation with respect to accretion of minerals is reduced. Since diagnostic imaging or invasive procedures such as a bone biopsy are still difficult to perform in swine, diagnostic methods easy to implement and providing meaningful results are of high practical impact. While it is usually not feasible to perform radiography in several pigs of a herd, taking several blood samples and pooling them for bone marker analysis is much more practical.

Nevertheless, the hypothesis of an additional nutritional impact on disease development could not be supported by bone composition and blood parameters in this case. Bone ashing in pigs is a further diagnostic approach to verify the suspicion of impaired mineralization of bone. Standardization of the method has been improved in the recent years, so that preliminary reference values could be elaborated for the femur [25]. Of high importance is the removal of adjacent tissue from the bone before starting the diagnostic procedure. Ca and P contents in dry matter of bone ash were within the reference ranges [25]. Bone ash diagnostic is of value for diagnostic of long-lasting marginal supply with minerals, which was not the case in this study. In growth periods with insufficient Ca and P supply, at first bone mass in total will be reduced, while bone formation and composition itself will be preserved, resulting in a lower ratio of the diameter of the long bones to body mass [25]. This might finally result in higher pressure forces (N/cm²) onto the articular cartilage especially in pigs with high growth rates.

Blood parameters shown in Table 5 vary within the reference range. A hypothesised low dietary P intake would be reflected by low P concentrations in blood as shown in Table 6 with data recorded in a feeding
experiment [25]. A comparison of P concentrations in blood of case animals (Table 5) with these experimental data revealed, that P concentrations in blood can be assessed as high. Blood concentrations reflect only the current P supply and are of diagnostic value for acute P deficiency.

For this reason, analysis of diet composition and feeding anamnesis are fundamental in the diagnostic procedure. The authors assume, that a marginal mineral supply during a specific juvenile phase of life with high growth rates might predispose for disease development in later life. In individuals with high growth rates (900–1000 g average daily weight gain) the uptake of digestible P might have been insufficient at the end of nursery/beginning of fattening, also with a high P digestibility of 60% as shown in Table 2. These pigs would be undersupplied with only 4.6 g P/kg in the respective diets (Table 1), especially in the case that feed processing as pelleting or granulating had reduced phytase activity. To diagnose a marginal mineral supply in critical growth phases, the demand of the pigs with respect to feed intake and growth rate must be calculated. Different batches of compound feed vary in P and Ca concentrations, which can lead to deficiencies especially if original concentrations are low. Labelled diet compositions are only based onto an analysis in the first charge. In general, digestibility of dietary P is markedly improved by a fermentation of the liquid diet (for about 24 h) prior to its offer and by adding phytase to the compound feed [26–28]. Both strategies were realised in the study farm.

The primary hypothesis was, that the development of the disease was a multifactorial process starting with an impaired bone mineralization. Mineral deficiency osteopathy, caused by inadequate P or insufficient P availability in the diet, might trigger development of osteochondropathy of the joints [29]. But there were also studies which could not indicate hypophosphatemia as an etiological factor in the development of OC [30]. Next to hereditary factors rapid growth with early excess weight is a major risk for dyschondroplasia in physeal and epiphyseal locations [31, 32], which is accompanied by a premature regression of blood supply. Microscopic focal lesions or necrotic chondrocytes below the interface of articular or within the epiphyseal growth cartilage, which were replaced by fibrous connective tissue, can undergo calcification. Lesion development can already start in the age of 4 weeks of life with a widening of growth plate parts. Resulting deformation of the bones with incongruity in cartilage surfaces can result in osteoarthritis. The progress might be triggered by moving pigs from a relatively soft plastic floor in the nursery to a hard concrete floor in fattening. Especially heavyweight pigs might suffer from the sudden change in flooring, to which neither claw horn nor joints have been adapted to. The claw lesions found in lame pigs (Fig. 3) support the impact of flooring in this case.

Although the authors suggest, that a trias of three factors as marginal dietary P supply, degenerative joint alterations and joint infection might be responsible for the spectrum of symptoms, so far no connection between the development of OC and an undersupply of calcium or P has been proven [2]. Whether cartilage alterations as shown in these pigs predispose for colonization and infection with M. hyosynoviae is also still hypothetical. Other authors have also considered that OC could predispose joints to infection with M. hyosynoviae [33]. However, these assumptions were also refuted by authors who did not find M. hyosynoviae more frequently in individuals at the slaughterhouse with OC than in individuals without OC [8]. The infection of the joints with M. hyosynoviae can be asymptomatic, but the joints can
also be filled macroscopically with a yellow/brownish viscous fluid, which often has an enlarged volume, whereby in chronic cases the joint capsule can be extended [1]. In the present study a mild to moderate lymphoplasma-histiocytic inflammation as well as one fibrino-suppurative synovialitis were detected by histology. A slight increase in synovia volume was found in two of the pigs. While no periarticular edema was present, in one pig surrounding joint tissue was thickened. Infectious arthritis caused by \textit{M. hyosynoviae} often results in decreased profitability due to higher medication costs and time-consuming measures to be taken, as e.g. separation of diseased pigs in recovery pens. This infectious agent is in addition further impairing skeletal health in fatteners, which is an important welfare issue [2]. Due to the differing outcome of infection the identification of other trigger factors in affected farms is of high importance.

\textbf{Declarations}

\textbf{Ethics approval and consent to participate}

The present case report does not include experimental data and all further investigations were performed as routine diagnostics during the clinical outbreak. Therefore, animal ethics committee approval was not necessary.

\textit{Consent for publication}

Not applicable.

\textit{Availability of data and material}

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

\textit{Competing interests}

The authors declare that they have no competing interests.

\textit{Funding}

Not applicable.

\textit{Authors' contributions}

IH, EG and JT contributed to the conception and design of the present case report. BW conducted the literature study and wrote the first draft of the manuscript. JT, JV and MB performed the clinical examination and JV and MB performed the necropsy. JK, FH and HH gave helpful professional advice and helped with the processing in the areas of nutrition and pathology. All authors contributed to the development and the revisions of the manuscript and approved the final version.
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Figures
Figure 1

X-Ray findings of left knee of pig 3. An osseous tulip-shaped bulge at the distal epiphyseal cartilage of the femur as well as incongruities at the articular surface of the tibia are visible.
Figure 2

Macroscopic lesions in the knee of pig 3. Irregularities at the articular cartilage of the tibia are visible.
Figure 3

Macroscopic lesions at claws of pig 1 Volar surface of claws of the hind feet with erosive heel lesions and lesions of the coronary band at the dew claws.
Figure 4

Histological findings in stifle joints of pig 2. (A) Histopathology revealed a pannus formation at the articular cartilage of the femur with demasking of collagen fibers. (B) Within the physis multifocal cartilage cones (O) were detected. (C) Additional findings in the physis included multifocal chondrocyte degeneration (arrowhead) as well as eosinophilic streaks (arrow). (D) The synovial membrane revealed a severe fibrinopurulent (asterisk) inflammation. Hematoxylin and eosin staining, bars = 50 µm (A,C) and 200 µm (B,D).