UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

FACULDADE DE VETERINÁRIA

PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS VETERINÁRIAS

CARACTERIZAÇÃO PATOLÓGICA E BACTERIOLÓGICA DE LESÕES ARTICULARES EM SUÍNOS

REGINA TOSE KEMPER

PORTO ALEGRE

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REGINA TOSE KEMPER

CARACTERIZAÇÃO PATOLÓGICA E BACTERIOLÓGICA DE LESÕES ARTICULARES EM SUÍNOS

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RESUMO

Lesões articulares em suínos são frequentes e geralmente relacionadas a perdas econômicas para produtores e abatedouros. Artrites podem estar associadas a causas infecciosas e não infecciosas. Entre as artrite os agentes infecciosos mais comuns estão *Erysipelothrix rhusiopathiae*, *Streptococcus suis*, *Glaesserella (Haemophilus) parasuis*, *Mycoplasma hyorhinis* e *Mycoplasma hyosynoviae*, enquanto a osteocondrose é a causa não infecciosa mais importante em suínos. O objetivo deste estudo foi realizar a caracterização patológica e microbiológica de lesões articulares em suínos. As coletas foram efetuadas em dois frigoríficos no Estado do Rio Grande do Sul, Brasil. Um total de 8.808 suínos de 34 lotes foram examinados macroscopicamente durante o período do estudo. Cento e cinco lesões articulares foram coletadas, o que representou 1,19% dos suínos abatidos durante o período. As articulações femorotibiais direita e esquerda somadas foram as mais comumente envolvidas (39,04%), seguidas pelas articulações femorotibial direita (21,90%) e femorotibial esquerda (17,14%). Na microscopia, as lesões foram classificadas morfologicamente em sinovite linfoplasmocitica proliferativa (79,04%), sinovite associada com osteocondrose (12,38%) e sinovite fibrinonecrótica e supurativa (8,57%). Exame bacteriológico aeróbico foi realizado em todas as amostras coletadas. No entanto, o isolamento bacteriano foi raro e apenas 3,80% das amostras apresentaram crescimento com os métodos utilizados. As bactérias identificadas foram *Streptococcus suis* (1,90%), *Streptococcus porcinus* (0,95%) e *Trueperella pyogenes* (0,95%). No restante dos casos (96,19%), nenhum crescimento bacteriano significativo foi detectado. Portanto, o exame dos componentes articulares fornece informações sobre a natureza da lesão, diferenciando processos infecciosos de não-infecciosos. O exame de todas as articulações é importante para o diagnóstico mais preciso, bem como recomenda-se examinar mais de uma articulação quando a lesão macroscópica for evidenciada. O padrão histológico caracterizado como sinovite proliferativa linfoplasmacítica foi o mais frequentemente observado e análises moleculares são necessárias para definir a etiologia dessa lesão.

Palavras-chave: doenças de suínos, membrana sinovial, sinovite, *Streptococcus* sp., condenação.

ABSTRACT

Joint injuries in swine are common and frequently related to economic losses for producers and meat industry. Arthritis may derive from infectious and non-infectious process. Among the most common infectious agents are *Erysipelothrix rhusiopathiae, Streptococcus suis, Glaesserella parasuis* (*Haemophilus) parasuis*, *Mycoplasma hyorhinis*, and *Mycoplasma hyosynoviae*, while osteochondrosis is the non-infectious cause more important to swine. The objective of this study was to perform a pathological and microbiological characterization of articular lesions in swine. Articular lesions were collected in two slaughterhouses in the state of Rio Grande do Sul, Brazil. A total of 8,808 pigs out of 34 batches were examined during the study period. One hundred five joint injuries were collected, which represented 1.19% of the amount of slaughtered pigs during the study period. The right and left femorotibial joints alongside were the most affected articulations (39.04%), followed by right femorotibial (21.90%), and left femorotibial joint with (17.14%). The lesions observed were classified according to their morphology as lymphoplasmacytic proliferative synovitis (79.04%), synovitis associated with osteochondrosis (12.38%), and fibrinonecrotic and suppurative synovitis **(**8.57%). Aerobic bacterial culture was performed in all samples collected. However, bacterial isolation was rare and only 3.80% (4/105) samples showed growth with the methods used. The bacteria isolated were *Streptococcus suis* (1.90%), *Streptococcus porcinus* (0.95%), and *Trueperella pyogenes* (0.95%). In the rest of the cases (96.19%), no significant bacterial growth or no bacterial growth was noticed. Therefore, the examination of the articular structures provides insights into the nature of the lesion, differentiating between infectious and non-infectious lesions. Besides, the examination of all joints may be necessary to diagnosis more precisely. It is recommended to evaluate all joints when macroscopic alteration is found noticed in one. The histopathologic pattern of lymphoplasmacytic proliferative synovitis were the most frequently seen and molecular analysis is necessary to define the etiology of this lesion.

Keywords: swine diseases, synovial membrane, synovitis, *Streptococcus* sp., condemnation.

SUMÁRIO

1. INTRODUÇÃO

A implantação do sistema de integração proporcionou um crescimento expressivo na cadeia produtiva de suínos, e hoje o Brasil é o 4º maior produtor e exportador de carne suína do mundo. Estima-se que 81% da produção nacional é destinada para o mercado interno e 19% para exportação (ABPA, 2020). A região Sul é a maior produtora de suínos do país e detém 60% das matrizes tecnificadas do território nacional (ABCS, 2011). O entendimento das enfermidades que podem afetar esta espécie, é de fundamental importância para o planejamento da sanidade e consequente geração de conhecimento científico.

Dentre as afecções em suínos que merecem destaque, pode-se citar as lesões articulares (BUENO *et al*. 2013). As articulações sinoviais são compostas por cartilagem articular, estruturas ósseas adjacentes, membrana fibrosa, a qual realiza a fixação, membrana sinovial, responsável por produzir líquido sinovial e cápsula articular. Além disso, é local de inserção de diversos tendões e ligamentos (CRAIG *et al.* 2016). As articulações são as estruturas mais submetidas ao estresse mecânico no sistema locomotor e possuem uma estrutura de anastomose vascular que facilita a deposição de microrganismos e êmbolos sépticos. Assim, as articulações podem ser acometidas por diversas patologias inflamatórias e mecânicas (THACKER & MINION, 2012).

Na suinocultura diversos agentes infecciosos são responsáveis pelo desenvolvimento de artrite, no qual pode-se citar *Streptococcus suis*, *Haemophilus parasuis, Erysipelothrix rhusiopathiae*, *Mycoplasma hyorhinis* e *Mycoplasma hyosynoviae* (THACKER & MINION, 2012). Entretanto doenças degenerativas como osteocondrose, osteodistrofia fibrosa e lesões traumáticas, cursam com sinais clínicos similares e devem ser consideradas. A frequência de cada etiologia varia com a idade do suíno e as práticas de manejo. As perdas econômicas ocorrem devido a piora da conversão alimentar, perda de peso e eventuais mortes (JACKSON & COCKCROFT, 2007).

A osteocondrose constitui uma afecção de origem não infecciosa, comumente relacionada a claudicação em suínos nas fases de crescimento e terminação. Quando em sua fase *latens*, macroscopicamente caracteriza-se por formação de dobras cartilaginosas completas, fissuras, abas e ulceração da cartilagem com exposição de osso subcondral (CRAIG *et al.* 2016). Em um estudo realizado por Alberton *et al*. 2000, a osteocondrose foi a principal causa de lesão articular em suínos de abatedouro. Em relação as causas

infecciosas, *Mycoplasma hyosynoviae e Mycoplasma hyorhinis* são agentes bacterianos que devem ser considerados como diferencias de artrite em suínos. O *M. hyorhinis* pode induzir poliserosite e artrite e acomete suínos de 3-10 semanas de idade. Os sinais clínicos mais comumente encontrados são aumento das articulações, que contém em seu interior líquido serosanguinolento ou serofibrinoso, no qual pode evoluir para erosão da superfície articular. No exame *post mortem* observa-se hiperplasia da membrana sinovial (NEUMANN *et al.* 2009). *E. rhusiopathiae* também é capaz de causar lesões articulares em suínos de desmame e crescimento, desde que não haja proteção de imunidade passiva de colostro. As lesões estão associadas a febre e podem ser agudas ou crônicas, sendo esta última uma artrite proliferativa não-supurativa. Outra bactéria comumente observada em suínos com claudicação é o *Streptococcus suis* tipos 1, 2 e 14, que pode afetar suínos na creche e terminação, e provoca poliartrite supurativa aguda e por vezes meningite (JACKSON & COCKCROFT, 2007).

M. hyosynoviae é uma bactéria da classe dos Mollicutes, grupo ao qual pertence outros organismos patogênicos para suínos tais como *M. hyopneumoniae* e *M. hyorhinis* (THACKER & MINION, 2012), além de diversos patógenos em diferentes espécies como *M. bovis* em bovinos (PFUTZNER & SACHSE, 1996) e *M. gallinarum e M. synoviae* em aves (ADEYEMI *et al.* 2018, DROUAL *et al.* 1992). O controle destes agentes é desafiador, pois não respondem ao tratamento com antibióticos beta-lactâmicos devido sua característica estrutural, que consiste em ausência de parede celular. Além disso, podem apresentar resistência a diversos antibióticos frequentemente utilizados na suinocultura (MORONATO *et al*. 2017). No Brasil, *M. hyosynoviae* foi identificado pela primeira vez em suínos de abatedouro com artrite (ALBERTON *et al.* 2004). Neste estudo, observou-se uma prevalência de 6% dos casos investigados. Acredita-se que a transmissão do *M. hyosynoviae* ocorra da matriz para o leitão. Após o primeiro contato, a bactéria se aloja principalmente nas tonsilas e pode permanecer não patogênica e sem produzir anticorpos (CRAIG *et al.* 2016). Contudo, alguns fatores estão correlacionados e contribuem para o desenvolvimento da bacteremia, o que provoca a distribuição do agente para diversas articulações. Entre os principais fatores, destacam-se a ambiência, genética, estrutura corporal e peso dos suínos (ROSS, 1973).

A duração dos sinais clínicos de suínos infectados por *M. hyosynoviae* é variável e existe diferença na patogenia de acordo com a patogenicidade das cepas (GOMES-NETO *et al.* 2016). Os sinais clínicos podem durar cerca de dois dias ou se estenderem por 7 a

10 dias, e são caracterizadas principalmente por claudicação, dificuldade ou inabilidade de caminhar e levantar, rigidez e ocasionalmente inapetência, e febre não é observado (THACKER & MINION, 2012). As lesões macroscópicas se caracterizam por aumento de líquido sinovial serofibrinoso e serosanguinolento, além de moderada proliferação da membrana sinovial (MORONATO *et al.* 2017). Histologicamente, hiperplasia de células sinoviais e hipertrofia de vilos são os principais achados nas articulações com afecção clínica por *M. hyosynoviae* (ROSS 1973). Entretanto, *M. hyosynoviae* pode ser isolado até mesmo de articulações sem alterações macroscópicas (NIELSEN *et al.* 2001). Portanto, o exame macroscópico e microscópico é fundamental para o diagnóstico seguro.

Algumas infecções virais, como lesão muscular causada por Circovírus Suíno tipo 2 (KONRADT *et al.* 2018), devem ser incluídas no diagnóstico diferencial de alterações articulares em suínos. Febre aftosa e doença vesicular provocam lesões de cascos em banda coronária, o que também acarreta em claudicação (JACKSON & COCKCROFT, 2007).

Estudos com doenças articulares em suínos auxiliam a melhorar a acurácia do diagnóstico e as medidas de profilaxia cabíveis a serem tomadas, além de gerarem conhecimento científico na medicina de suínos. Além disso, ajudam os clínicos veterinários e os profissionais dos serviços de inspeção. Com isso, o objetivo desse estudo foi realizar a caracterização patológica e bacteriológica de lesões articulares em suínos. Esse estudo resultou em um trabalho científico, que está incluído na íntegra a seguir.

2. ARTIGO

Neste item é apresentado o artigo “Pathological and bacteriological characterization of articular lesions in swine”, redigido conforme as normas do períodico Pesquisa Veterinária Brasileira, a ser submetido após as contribuições da banca examinadora.

Pathological and bacteriological characterization of articular lesions in swine[1]

Regina Tose Kemper[2], Welden Panziera[2], Jacqueline Raiter[2], Bruna Correia Lopes[2] and David Driemeier[2]

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Joint injuries in swine are frequent and generally related to economic losses for producers and meat industry. Arthritis may happen due to infectious and non-infectious causes. The objective of this study was a pathological and bacteriological characterization of articular lesions in swine. Swine articular lesions were collected in two slaughterhouses in the state of Rio Grande do Sul, Brazil. The sample collection happened in January and April of 2019, and they took one week each. All joints considered with an abnormal appearance was diverted to the Departamento de Inspeção Final (D.I.F) and closely examined for lesions. Samples from the lesions were collected systematically for histologic and microbiologic analysis. A total of 8,808 pigs out of 34 batches were examined during the study period in both slaughterhouses. One hundred five joint injuries were collected, which represented 1.19% of the amount of slaughtered pigs. The bilateral involvement of the femorotibial joints were most commonly involved articulation (39.04%), followed by right femorotibial (21.90%) and left femorotibial joint with (17.14%). The lesions observed in the joints were morphologically classified into lymphoplasmacytic proliferative synovitis (79.04%), synovitis associated with osteochondrosis (12.38%), and fibrinonecrotic and suppurative synovitis (8.57%). The bacterial agents identified in the lesions were subdivided according to the histological pattern. The microbiological analysis was performed in all samples collected. However, bacterial isolation was rare and only 3.80% of the samples showed growth with the methods used. The identified bacteria were *Streptococcus suis* (1.90%), *Streptococcus porcinus* (0.95%), and *Trueperella pyogenes* (0.95%), these isolates were correlated with fibrinonecrotic and suppurative synovitis. In the rest of the cases (96.19%), no significant bacterial growth or no bacterial growth was detected. The evaluation of joint components provides information on the nature of the lesion, differentiating between infectious and non-infectious processes. Examination of all joints is important for the most accurate diagnosis, and it is recommended to examine more than one joint when the macroscopic lesion is evident. Lymphoplasmacytic proliferative synovitis was the histological pattern most frequently observed and molecular analyzes are necessary to define the etiology of this lesion.

INDEX TERMS: swine diseases**,** synovial membrane, synovitis, bone, *Streptococcus* sp., condemnation, slaughterhouse study.

RESUMO [Caracterização patológica e microbiológica de lesões articulares em suínos.] Doenças articulares em suínos são frequentes e geralmente relacionadas com perdas econômicas para a indústria e produtores. Artrites podem ser de origem infecciosa e não-infecciosa. O objetivo deste estudo foi realizar a caracterização patológica e bacteriológica de lesões articulareso de suínos. As alterações articulares foram coletadas em dois abatedouros de suínos no Estado do Rio Grande do Sul, Brasil. As coletas das amostras ocorreram em janeiro e abril de 2019 e duraram uma semana cada. Todas as articulações consideradas com aparência anormal e desviadas para o Departamento de Inspeção Final (D.I.F.) foram examinadas. Amostras foram coletadas sistematicamente para análise histológica e microbiológica. Um total de 8.808 suínos de 34 lotes foram examinados durante o período do estudo em ambos os matadouros. Cento e cinco lesões articulares foram coletadas, o que representou 1,19% dos animais abatidos. O envolvimentom bilateral das articulações femorotibiais direita e esquerda foi o mais comumente observado (39,04%), seguidas pelas

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articulações femorotibial direita (21,90%) e femorotibial esquerda (17,14%). As lesões observadas nas articulações foram classificadas morfologicamente em sinovite linfoplasmocítica proliferativa (79,04%), sinovite associada a osteocondrose (12,38%) e sinovite fibrinonecrótica e supurativa (8,57%). Os agentes bacterianos identificados nas lesões foram subdivididos de acordo com os padrões histológicos. Análise microbiológica foi realizada em todas as amostras coletadas. No entanto, o isolamento bacteriano foi raro e apenas 3,80% das amostras apresentaram crescimento com os métodos utilizados. As bactérias identificadas foram *Streptococcus suis* (1,90%), *Streptococcus porcinus* (0,95%) e *Trueperella pyogenes* (0,95%), sendo que o isolamento bacteriano foi correlacionado com o padrão histopatológico de sinovite fibrinonecrótica e supurativa. No restante dos casos (96,19%), nenhum crescimento bacteriano significativo ou crescimento bacteriano foi detectado. A avaliação dos componentes articulares fornece informações sobre a natureza da lesão, diferenciando processos infecciosos de não-infecciosos. O exame de todas as articulações é importante para o diagnóstico mais preciso, bem como recomenda-se examinar mais de uma articulação quando a lesão macroscópica for evidenciada. O padrão histológico caracterizado como sinovite proliferativa linfoplasmacítica foi o mais frequentemente observado e análises moleculares são necessárias para definir a etiologia dessa lesão.

TERMOS DE INDEXAÇÃO: doenças de suínos, membrana sinovial, sinovite, osso, *Streptococcus* sp., condenação, estudo em abatedouro.

INTRODUCTION

Articulations are primarily classified as fibrous, cartilaginous, and synovial. Mostly found in the appendicular skeleton, the synovial joints are composed of articular cartilage, that covers the bones' extremities, an articular capsule, and synovial fluid that fills the cavity (Craig et al. 2016). Joint injuries in swine are frequent and generally result in economic losses for producers and meat industry (Jensen et al. 2012). Arthritis in swine may happen due to infectious as well as non-infectious causes (Madson et al. 2019), and the differentiation among these pathologies is important due to the zoonotic nature of some agents, such as *Erysipelothrix rhusiopathiae* (Boo et al. 2003) and *Streptococcus suis* (Nghia et al. 2008). *E. rhusiopathiae* is a gram-positive bacterium, which in humans may lead to endocarditis, cutaneous, and systemic infection (Robson et al. 1998). This bacterium is related to occupational activities such as pig farming (Boo et al. 2003) and is correlated with arthritis, in the finishing phase in pigs (Johnston et al. 1987). Furthermore, *S. suis* is a causative agent of septicemia, meningitis, polyarthritis, polyserositis, and valvular endocarditis in pigs (Gottschalk & Segura 2019). Other infectious agents that are responsible for the development of arthritis in pigs are *Glaesserella parasuis* former *Haemophilus parasuis* (Riley et al. 1977), *Mycoplasma hyorhinis* (Barden & Decker 1971), and *Mycoplasma hyosynoviae* (Nielsen et al. 2001*).*

Osteochondrosis (OC) is a noninfectious condition commonly related to arthritis in pigs in the finishing phases (Johnston et al. 1987). It is a multifactorial disease characterized by failure of endochondral ossification in the physeal growth plate or articular-epiphyseal cartilage (Craig et al. 2016). It can be divided into three presentations: osteochondrosis latens, osteochondrosis manifesta, and osteochondrosis dissecans as proposed by Ytrehus et al. 2007. Osteochondrosis was found to be the main cause of joint damage in slaughter pigs in Brazil (Alberton et al. 2000).

Lesions in the joint may cause partial or total carcass condemnation according to the severity and overall condition of the animal (RIISPOA, 2017). Besides, lameness, frequently attributed to the musculoskeletal system and potentially including joint diseases, could lead to economic loss as well have a negative impact on the welfare of animals (Jensen et al. 2012). Studies of causes of condemnation of carcasses in slaughterhouses may provide insights of the herd health status and diseases process. Investigation of these entities might be useful to improve the understanding of the diseases and the creation of plans to decrease the lost cause by them (Bueno et al. 2013, Tassi & Molento 2019). Furthermore, studies with swine articular diseases help to improve the accuracy of the diagnosis and are of major importance for industries and producers. Thereby, the objective of this study is a pathological and bacteriological characterization of articular lesions in swine.

MATERIALS AND METHODS

Swine articular lesions were collected in two slaughterhouses in the state of Rio Grande do Sul, Brazil. Each sample collection took one week and happened in January and April of 2019. One of the slaughterhouses was located in the city of Osório, which was under state inspection. The second was

located in Lajeado, and it is under federal inspection. Data regarding sex, age, and condemnation rates of the swine sampled were obtained from the slaughterhouse files. All joints were considered an abnormal appearance by the staff in the slaughtering line and were diverted to the Departamento de Inspeção Final (D.I.F) to be closely examined for lesions. The samples were visually observed and palpation was performed to identify changes in the fluctuation and location of joint structures. After that, the joints were opened and the articular cartilage, articular capsule, synovial fluid, and subchondral bone were all systematically assessed. The femorotibial, humeroradial, tarsus and coxofemoral joints were examined, and when macroscopic changes were noticed materials were coleted. The macroscopic description and information about the animals were recorded in a spreadsheet. During the macroscopic examination, articular cartilage presenting a full-thickness cartilaginous buckle, flap, or ulcer were classified as osteochondrosis , according to criteria present in previous studies in domestic animals (Craig et al. 2016).

Samples from the lesions were collected systematically for histologic and microbiologic analysis. Bone, tendons, synovial membrane, and muscles were collected in formalin 10%. They were then routinely processed, stained for hematoxylin and eosin (HE), and evaluated through light microscopy. The bone tissue samples underwent decalcification in 8% nitric acid, after fixation in formalin and then processed as above. Histopathological analysis was carried out, and the alterations were classified according to their morphological aspect. The lesions were also categorized for their histologic appearance and a morphological diagnosis was given. The joints were opened with a disinfected knife while in the D.I.F. and a medical sterile transport medium swab was performed. These swabs were submitted to microbiology analysis. Aerobic cultivation with agar blood and MacConkey for 24-48 hours was performed. When bacterial growth was noticed, biochemistry tests were run to determine the etiology (Markey et al. 2013).

RESULTS

A total of 8,808 pigs out of 34 batches were examined during the study period in both slaughterhouses. One hundred five animals with joint injuries were collected, which represented 1.19% of the amount of slaughtered pigs. The slaughterhouse of Osório is independent and purchases swine from different producers that are not connected to an integrated swine productive system. The slaughterhouse of Lajeado, slaughters pigs raised in integrated swine productive facilities. The pigs slaughtered had a medium weight of 127.12kg and an estimating age of 170 days of life. Both male and female were included in the study, and sometimes the batches formation were blended.

The distribution of the affected joints can be visualized in Table 1. In 43.80% of the cases, only one joint was affected, while in 52.2% of the cases a bilateral or more than one joint location was involved. The bilateral involvement of femorotibial joints were most commonly presentation (39.04% [41/105]), followed by right femorotibial (21.90% [23/105]) and left femorotibial joint with 17.14% (18/105). All samples presented hypertrophy of the synovial membrane in some degree, with the coloration that varied from yellow (34.28% [36/105]) to dark-red (65.72% [69/105]). The synovial liquid was increased in volume in 97.1% (102/105) of the samples collected; those would present decreased viscosity, and the coloration varied from red in 77.45% (79/102) to yellowish in 22.55% (23/102). In addition, fibrin molds were seen floating in the joint space in 42.15% (43/102) of the samples analysed.

The lesions observed in the joints were morphologically classified into lymphoplasmacytic proliferative synovitis (79.04% [83/105]), synovitis associated with osteochondrosis (12.38% [13/105]), and fibrinonecrotic and suppurative synovitis (8.57% [9/105]). The bacterial agents identified in the lesions were subdivided according to the histological pattern. The bacteriological analysis was performed in all samples collected. However, bacterial isolation was rare and only 3.80% (4/105) samples showed growth with the methods used. The identified bacteria were *Streptococcus suis* (1.90% [2/105]), *Streptococcus porcinus* (0.95% [1/105]), and *Trueperella pyogenes* (0.95% [1/105]). In the rest of the cases (96.19% [101/105]) no significant bacterial growth or no bacterial growth was detected.

Lymphoplasmacytic proliferative synovitis were seen in 79.04% (83/105) of the cases. The macroscopic changes observed mainly consisted of a feathery hypertrophy of the synovial villi; some joints presented polypoid hypertrophy of the synovial membrane, and pannus formation that varied in severity from mild to severe (Fig.1A and 1B). Histologically, lymphoplasmacytic proliferative synovitis is characterized by discrete to marked proliferation of the synovial membrane, frequently forming digitiform prolongations, with hypertrophy and hyperplasia of type II synoviocytes, inflammatory infiltrate of lymphocytes, plasma cells and macrophages (Fig.1D). Lymphoid nodules sometimes with germinal centers, and central vessels were seen frequently in the subintima of the

synovial membrane. There are still marked neovascularization, discrete to moderate proliferation of connective tissue, multifocal areas of hemorrhage and discrete necrosis predominantly in the germinal centers (Fig.1E). To a lesser extent, fibrin deposition, and inflammatory infiltrate of neutrophils associated with focal areas of loss of synovial membrane was seen in rare cases. In this morphological pattern, no significant bacterial growth or no bacterial growth was detected.

Synovitis associated with osteochondrosis were noticed in 12.38% (13/105) of the cases. Only cases of osteochondrosis dissecans were included in this study. The macroscopic changes were articular cartilage fissure, fibrillation, articular cartilage detachment and flap formation, loss of articular cartilage with ulcer formation and exposition of the subchondral bone. Those lesions were seen with moderate to discrete feathery hypertrophy of synovial villi and pannus formation (Fig.2A, 2B and 2C). Two cases split in the epiphyseal plate and metaphysis, associated with an abundant fibrin deposition and necrotic debris (slipped capital femoral epiphysis), were noticed. The locations where osteochondrosis were noted included medial epicondyle humerus associated with ulcer in the edge of the radius, femur head, and femoral condyle. We did not notice symmetrical or bilateral lesions; however, hypertrophy of synovial villi was frequently seen in others articulation. Microscopically, the bone lesions varied from thickening of the articular cartilage characterized by a focal area of bone resorption associated with the presence of osteoclasts, with replacement by fibrous connective tissue. Some of them presented discontinuity of the articular cartilage associated with infiltration of fibroblast and proliferation of connective tissue in the subchondral bone, fibrin deposition, bone resorption, and moderate multifocal inflammatory infiltrate of neutrophils. Insignificant bacterial growth or no bacterial growth was detected. In the synovial membrane, 10 cases (10/12) were observed with lymphoplasmatic proliferative synovitis. Those were characterized by discrete to moderate proliferation of the synovial membrane with digitiform prolongation, proliferation of connective tissue, neovascularization, and proliferation of type II synoviocytes. There are mild multifocal inflammatory infiltrates composed of lymphocytes, and plasma cells, and formation of lymphoid aggregate in severe cases. Cartilage fragments were sporadically seen in the surface or involved by the synovial membrane (Fig.2D). Two cases (2/12) were associated with slipped capital femoral epiphysis and showed fibrinosuppurative and fibrinonecrotic synovitis, as well as myositis.

Another morphological pattern noticed was fibrinonecrotic and suppurative synovitis in 8.57% (9/105) of the samples collected. Most of the joints included in this group were enlarged, and when cutting, an abundant amount of purulent and friable material, yellowish in color was noticed (fibrin molds). There was also polypoid hypertrophy of the synovial membrane, which was red (Figs.3A, 3B and 3C). Histologically this pattern presented markedly extensive necrosis of the synovial membrane, with marked fibrin deposition, cellular debris, and inflammatory infiltrate of nondegenerate and degenerate neutrophils, and to a lesser extent macrophages, lymphocytes and plasma cells (Figs.3D, 3E and 3F). In some areas there was moderate synovial membrane proliferation associated with the inflammatory infiltrate of lymphocytes and plasma cells, as well as a proliferation of type II synoviocytes. Proliferation of immature granulation tissue and hemorrhage has also been noticed. Of the 9 cases in this group, there was bacterial growth in 4, which included: *S. suis* (2/4), *S. porcinus* (1/4), and *T. pyogenes* (1/4).

Moreover, lesions in structures adjacent to the synovial joint were evaluated. Alterations in tendons were seen in 18.09% (19/105), and in skeletal muscle 13.33% (14/105). In tendons, the lesions were restricted to the tendon sheath that surrounded the epitenon, characterized by moderate to marked proliferation of the synovial membrane, associated with a variable degree of inflammatory infiltrate of lymphocytes and plasma cells characterizing tenosynovitis (Figs.1C and 1F). In the skeletal muscle adjacent to the synovial joint, the lesions varied from areas of a marked proliferation of fibrous connective tissue associated with inflammatory infiltrate of macrophages, multinucleated giant cells, lymphocytes, and plasma cells to acute lesions characterized by focally extensive hemorrhage and fibrin deposition to marked inflammatory infiltrate of nondegenerate and degenerate neutrophils, fibrin deposition, and necrosis of muscle fibers.

DISCUSSION

The diagnosis of cases of articular lesions in swine in this study was obtained through the association of gross, histopathological, and bacterial findings. A total of 1.19% of the pigs slaughtered in the period of the study presented some degree of the articular lesion, that was either sent to the D.I.F or condemned before the slaughter. Even if the lesions to the limb were not severe enough to be discarded, the simple act of passing through the D.I.F. disqualified the product. The rate of arthritis

for condemnation varies among studies. Cross & Edwards (1981), showed a prevalence of 1.07% of arthritis in an abattoir, similar to the result found in this research. A retrospective study of causes of condemnation in the swine industry in Brazil noticed asymmetrical behavior of the relative amount of carcass condemned for arthritis and polyarthritis showing 6.81%, 3.08%, and 4.43% during three years of the study (Bueno et al. 2013). In this study, the cause or characterization of the lesions was not performed. Different rate of condemnation by arthritis is found in growth-retarded pigs in Spain where 7.48% of the carcass presented joint lesions (Martínez et al. 2007). We considered our finding as a high rate of arthritis. Rates above 0.7 are considered expressive (Morés et al. 2003). The causing agent of arthritis in swine might vary by their age (Faria et al. 2011), however, the weight of the animal might intensify lameness (Madson et al. 2019), and convey the impression that animals in the finishing phase are more affected articular lesion than those in other phases.

The most affected joint in this study was the right and left femorotibial joint, being the right and left affected alongside or independently. The femorotibial and humeroradial were found to be the most common site of arthritis (Cross & Edwards 1981); Ross 1973 reported femorotibial joint as the most involved by arthritis in pigs with *M. hyosynoviae*. The detection of joint swelling in the older and heavier animals may be difficult to distinguish (Madson et al. 2019), including the finishing pigs such as the ones included in the present study. In addition, the destiny of the limbs varied according to the lesion severity and structures involved as defined by the Art. 196 § 1º of the *Regulamento da Inspeção Industrial e Sanitária de Produtos de Origem Animal* (RIISPOA, 2017) recommends that carcasses with arthritis in one or more joints, with lymph node reacted, hypertrophy of the synovial membrane, without repercussions in its general condition, should be selected for conditional use by heat treatment. In 52.2% of the cases, more than one joint was involved, and this information demonstrates two points: the need to examine all the joints when one of them shows macroscopic changes; and that condemnation may occur in more than half of the carcass diverted to the D.I.F. due to articular changes.

The majority of the cases were diagnosed histologically as lymphoplasmacytic proliferative synovitis without isolation of bacteria by the methodology used. The cases in this group also did not present a macroscopic aspect similar to osteochondrosis. Other reports have identified a considerable number of synovitis cases without any conclusion regarding the etiology (Johnston et al. 1987, Alberton et al. 2000). We hypothesized that the lower number of isolation may be due to fastidious bacteria from the genus Mycoplasma. *M. hyosynoviae* has been cited as the cause of condemnation in pigs with arthritis in Brazil (Alberton et al. 2003) and detected in animals with articular diseases mostly in the nursery phase (Faria et al. 2011). Due to its fastidious nature, *Mycoplasma* species are better diagnosed through real-time PCR (Polymerase chain reaction), alongside the gross and histological lesions (Neto et al. 2012), which are similar to the ones found in this study. Another explanation to the lack of etiology to this group may be correlated to the presence of antigenic particles in the joint, remaining from the bacterial wall and capable of leading an inflammatory response (Craig et al. 2016). Histological visualization of lymphoid follicles in the midst of the lesions was a constant finding in this pattern; these lymphoid nodules are seen in non-infectious disease such as rheumatoid arthritis in humans (Tsubaki et al. 2005), and osteochondrosis in pigs (Johnston et al. 1987). In addition, the presence of lymphoid nodules was related to infectious agents as well, including *Mycoplasma bovis* infectious in cattle (Gagea et al. 2006, Ryan et al. 1983) and *E. rhusiopathiae* in pigs (Johnston et al. 1987). We believe that these lymphoid nodules are related to lesion severity other than to an etiology, and that most of the cases in this pattern might be related to Mycoplasma although we have not proven it yet.

Lymphoplasmacytic synovitis associated with osteochondrosis was the second most common pattern noticed. The histopathological and macroscopic findings were similar to those noticed in other studies (Johnson et al. 1987, Alberton et al. 2000). In the cases where a slipped capital femoral epiphysis was not present, the microscopic findings diverted to a more fibrinous in nature, although no bacteria were cultured. Osteochondrosis has been considered to be the main cause of arthritis in pig slaughter in Brazil, with an incidence of 50% (Alberton et al. 2000) and 70% (Althaus et al. 2005). The pathogenesis and risk factors regarding this condition is not fully elucidated yet. However, focal alteration of the blood supply in the cartilaginous channels can be a triggering factor for osteochondrosis, and this alteration is compatible with local compression (Ythrehus et al. 2004). Kadarmideen et al. 2004 found positive correlations with osteochondrosis and improvement in daily weight gain and percentage of premium cuts, leading to the conclusion that selection to animals with such traits would increase the incidence of OC. In addition, trauma has been correlated to the development of this condition, when free-range animals have shown an increased prevalence of osteochondrosis (Etterlin et al. 2014). Our study diverts greatly from their previous findings in the

country. We cannot affirm the reason for such a change since the condition is multifactorial and more studies are necessary to determine what has changed over time, whether was a genetic component or husbandry, once both are involved in the development of this condition.

Fibrinonecrotic and suppurative synovitis was the third pattern described, and part of these cases (approximately 45%) were associated with bacterial isolation. We noticed that the macroscopic appearance was strikingly different in this group in relation to the others, and these cases were characterized by an abundant amount of fibrin molds or purulent material filling the synovial space and marked hyperemia of the synovial membrane. It is important to highlight that the chronic stage of these lesions may involve the lymphoplasmacytic lesion (Craig et al. 2016). We noticed that in one case that *S. suis* was etiology of the macroscopic appearance change. A striking finding in our study was the lower-yielding of bacterial isolation. However, the rate of bacterial isolation varies among the studies (Johnston et al. 1987, Moraes et al. 1991, Alberton et al. 2000, Faria et al. 2011). We believe that differences in the present study in relations to the others may be due to a high prevalence of *Mycoplasma hyosinoviae*. Among bacterial agents, *Streptococcus suis* and *S. porcinus* were the most common bacteria isolated. These microorganisms, associated with *Mycoplasma* spp., *E. rhusiopathiae*, *T. pyogenes, Staphylococcus* spp., and other species of *Streptococcus* are commonly described in swine articular lesions (Hariharan et al. 1992, Martínez et al. 2007, Faria et al. 2011, Craig et al. 2016). The richly vascular synovial membrane appears to be a favored site for localization of bacteria (Craig et al. 2016), and due to the absence of the limiting basement membrane frequently bacteria load in the synovium via hematogenous route and lead to local inflammatory response (Smith & Piercy 1995).

Lesions in tendons and skeletal muscle were noticed among the different patterns, demonstrating that structures nearby should also be screening for lesions. All tendon lesions were defined as tenosynovitis, decreasing the capacity of the tendon sheath to glide, leading to pain, and may progress to motion alterations and deformity (Ray & Tall 2020). In pigs, purulent tenosynovitis has been described (Brandreth & Smith 1987), but this condition has not been reported or discussed in recent years. We believe that the inflammation of the tendon sheath was a continuity injury from the synovial membrane, and the lesion may exacerbate the clinical signs related to arthritis. Although the dissemination of the synovial infection to the adjacent soft tissue is considered rare (Craig et al. 2016), the number of cases involving muscular lesion emphasizes the importance to investigate articular diseases in animals intended for human consumption, once it can affect food security.

CONCLUSIONS

The results allow us to conclude that the proliferative lymphoplasmacytic synovitis was the main morphological pattern, in which synovial membrane proliferation was main lesion. Molecular analysis is necessary to define the etiology these alterations. The group synovitis associated with osteochondrosis was characterized by ulcerative cartilaginous and bone lesions, differing from the other patterns. The pattern of fibrinonecrotic and suppurative synovitis was correlated with the rare cases of bacterial isolation in the study, these being *Streptococcus suis* (1.90%), *Streptococcus porcinus* (0.95%) and *Trueperella pyogenes* (0.95%). The examination of the articular components provides insights into the nature of the lesion, differentiating mainly nonsuppurative to suppurative process, as well as non-degenerative to degenerative lesions. Examination of all joints may be necessary to conclude the diagnosis more precisely and is recommended when one articulation is altered; even though the others are not swollen.

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Table 1. Location and distribution of affected joints.

Affected joints	Total cases	Frequency (%)
R.L Femorotibial	41	39.04%
R. femorotibial	23	21.90%
L. femorotibial	18	17.14%
L. and R. femorotibial and R. humeroradial	4	3.80%
R. and L. femorotibial and R. and L. tarsus	4	3.80%
R. humeroradial	3	2.85%
R. and L. humeroradial	2	1.90%
R. and L. femorotibial and R. coxofemoral	2	1.89%
L. humeroradial	1	0.96%
R. femorotibial and L. humeroradial	1	0.96%
R. femorotibial and R. coxofemoral	1	0.96%
L. femorotibial and L. coxofemoral	1	0.96%
L. humeroradial, L. coxofemoral, L. femorotibial and R. and L. tarsus	1	0.96%
L. humeroradial, L. coxofemoral, L. femorotibial and tarsus	1	0.96%
R. Tarsus	1	0.96%
All joints	1	0.96%
Total	105	

Legend: R= Right. L= left.

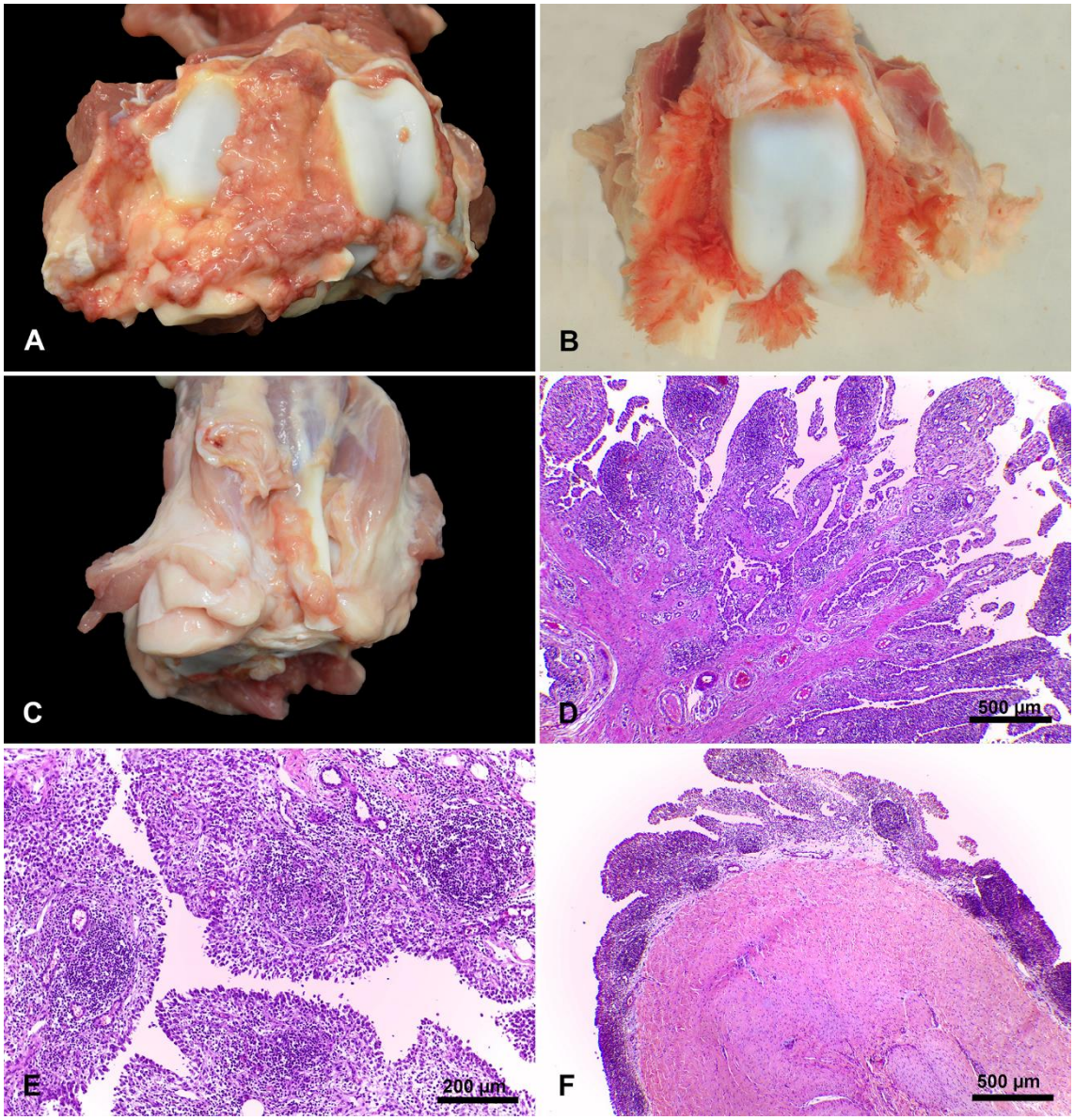

Fig.1: Lymphoplasmacytic proliferative synovitis. (**A**) Femorotibial joint with marked polypoid hypertrophy of synovial membrane. (**B**) Underwater photo. Femorotibial joint with marked feathery hypertrophy of synovial membrane. (**C**) Tendon sheath presenting moderate hypertrophy of the synovium. (**D**) Histology. Lymphoplasmacytic proliferative synovitis**,** characterized by marked proliferation of the synovial membrane, frequently forming digitiform prolongations. Hematoxylin and eosin (HE). (**E**)Closer image of the hyperplastic synovial membrane, showing several lymphoid follicles. There is also a marked inflammatory infiltrate of lymphocytes, plasmocytes and macrophages, and proliferation of synoviocytes. HE. (**F**) Tenosynovitis. There is marked proliferation of the synovial membrane that surrounds the epitenon, associated with a marked diffuse inflammatory infiltrate. HE.

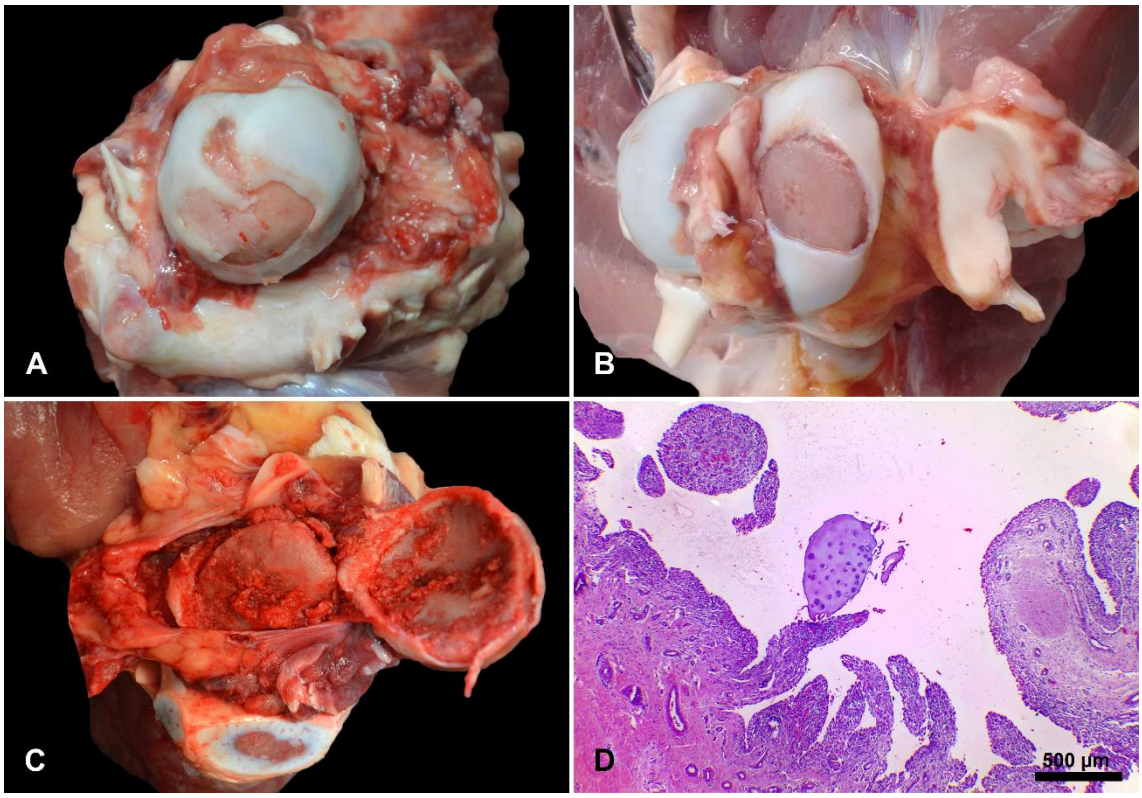

Fig.2: Synovitis associated with osteochondrosis. (**A**) Femur head with loss of articular cartilage with ulcer formation, fibrillation, and exposition of the subchondral bone in the femur head associate with discrete hypertrophy of the synovial membrane. (**B**) Femoral condyle with ulcer formation and exposition of the subchondral bone. (**C**) Femoral head with split in the epiphyseal plate and metaphysis associated an abundant fibrin deposition and necrotic debris (slipped capital femoral epiphysis) and discrete hypertrophy of the synovial membrane. (**D**) Histology. Moderate proliferation of the synovial membrane with digitiform prolongation, proliferation of connective tissue, and neovascularization, associated with inflammatory infiltrate mononuclear. Cartilage fragments are seen in the surface of the synovial membrane. HE.

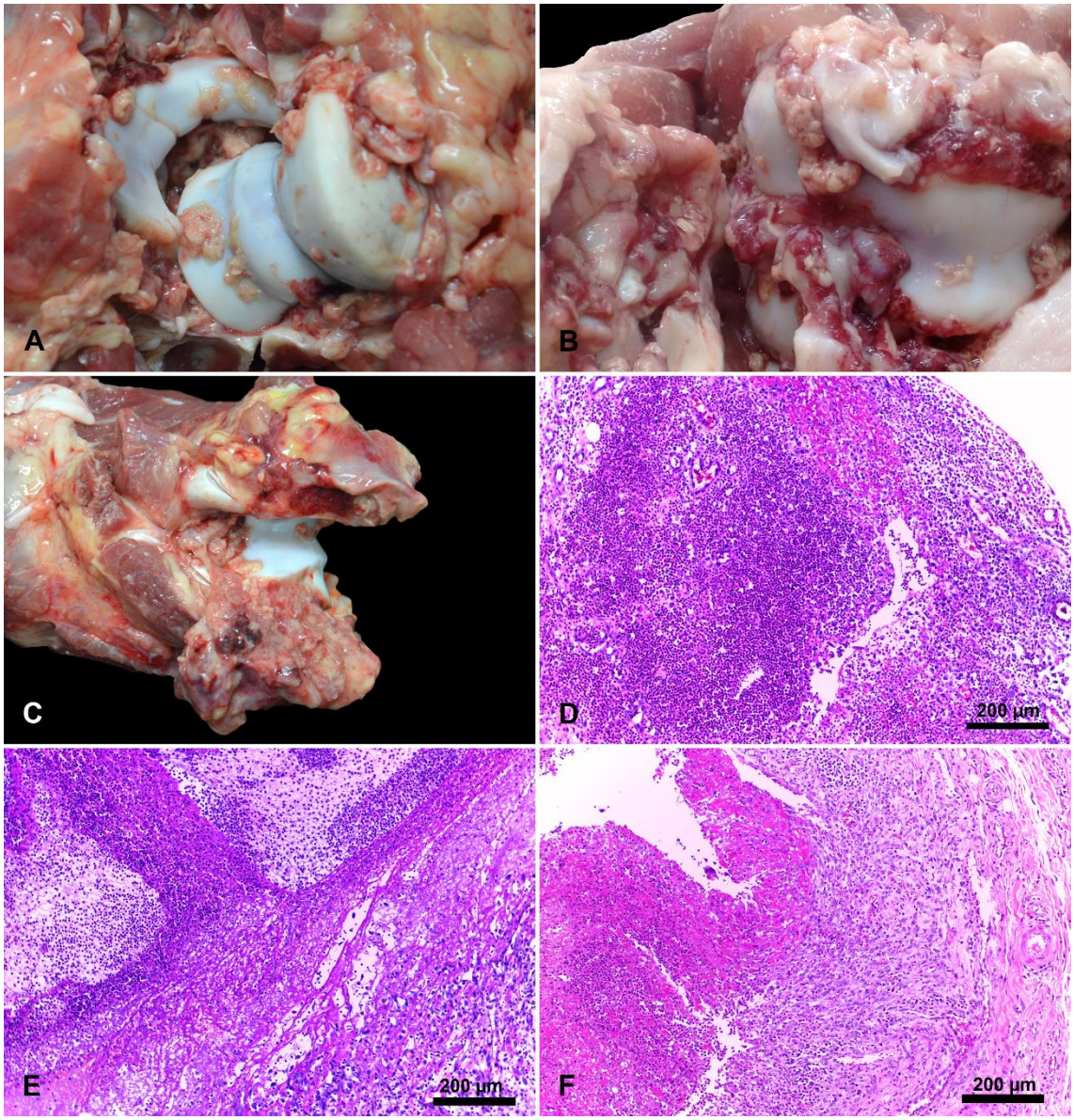

Fig.3: Fibrinonecrotic and suppurative synovitis. (**A**)Humeroradial joint with abundant amount of fibrin molds covering the bone structures, associated with marked hyperemia and mild hypertrophy of the synovial membrane (synovitis for *Streptococcus suis*). (**B**) Femorotibial joint with abundant amount of fibrin molds covering the bone structures associated with marked hyperemia and mild hypertrophy of the synovial membrane (synovitis for *Streptococcus porcinus*). (**C**) Humero radial joint with marked hyperemia and mild hypertrophy of the synovial membrane. Note the muscular edema and multifocal areas of hemorrhage (synovitis for *Streptococcus suis*). (**D**, **E**, **F**) Histology. In the synovial membrane, marked extensive areas of necrosis, with marked fibrin deposition, cellular debris, and inflammatory infiltrate. HE

3. CONCLUSÕES

Neste estudo, um total de 8.808 carcaças de suínos de 34 lotes diferentes foram avaliados e 105 carcaças com alterações articulares foram evidenciadas representando uma taxa de 1,19% de frequência de lesões articulares em suínos abatidos durante o período do estudo. Esse dado demonstra que alterações articulares é um problema com relevância econômica e sanitária em suínos de terminação.

A articulação mais afetada neste estudo foi a articulação femorotibial direita e esquerda, sendo estas afetadas individualmente ou juntas. Em 52,2% dos casos, mais de uma articulação estava envolvida, o que demosntra a necessidade de examinar todas as articulações quando uma delas apresenta alterações macroscópicas. Associando esses dados a atual legislação, observa-se a condenação de metade das carcaças desviadas para o D.I.F. devido a alterações articulares.

Os padrões histológicos observados foram sinovite proliferativa linfoplasmocítica (79,04%), sinovite associada a osteocondrose (12,38%) e sinovite fibrinonecrotica e supurativa (8,57%). Na sinovite proliferativa não houve crescimento de nenhum agente nos métodos de cultivo bacteriológico utilizado, sugerindo *M. hyosynoviae* como possível etiologia das lesões. Com isso, há a necessidade de técnicas moleculares para confirmação ou exclusão da suspeita. Nos casos de sinovite associada com osteocondrose, observou-se o predomínio de lesões ulcerativas e necróticas articulares, com envolvimento ósseo. Essas características morfológicas o diferiu dos outros dois padrões. O padrão de sinovite fibrinonecrótica e supurativa foi correlacionado com os raros casos de isolamento bacteriano do estudo, sendo esses *Streptococcus suis* (1.90%), *Streptococcus porcinus* (0.95%) e *Trueperella pyogenes* (0.95%).

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