



Review Article

**JOINT DISEASES IN ANIMAL PALEOPATHOLOGY:
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ABSTRACT

Animal paleopathology is not a very well known scientific discipline within veterinary science, but it has great importance for historical and archaeological investigations. In this paper, authors attention is focused on the description of one of the most common findings on the skeletal remains of animals - osteoarthropathies. This review particularly emphasizes the description and classification of the most common pathological changes in synovial joints. The authors have provided their observations on the importance of joint diseases in paleopathology and veterinary medicine. Analysis of individual processes in the joints of the animals from the past may help in the understanding of diseases in modern veterinary medicine. Differential diagnosis was made a point of emphasis and discussion, so that this work could have practical significance for paleopathology and veterinary medicine.

Key words: joint diseases, paleopathology, veterinary medicine, archaeozoology

INTRODUCTION

Animal bones are common archaeological finds and it is well-recognised that their detailed study provides important information about past human activities (7, 8, 9). The major part of faunal assemblages are domestic animals skeletal remains (27). The identification and correct description of pathological changes plays significant role in understanding of the human-animal interactions in daily life in the past (15). Usually, osteological changes observed in the past within animal bones are the result of human activity and the character

of animal utilization. The interpretation should be related with socio-cultural aspects (18, 20, 21). For example, the characteristic changes in the distal parts of the limbs in cattle coming from the territory of the Roman Republic and Empire are in close relationship with the Roman economy, dietary tradition and animal utilization (1, 4, 11, 26). In this context, the possible interpretations should follow this direction. Some skeletal pathologies typical for the animals from the past are not observed nowadays, because of wide technological, social and other factors strongly influencing the animal herding and utilization methods.

The first pathological changes in joints in domestic animals were detected in Roman-British dog remains (13). Following these widely reported cases, many surveys since have been demonstrating the high prevalence of arthropathies in archaeozoological material (2, 32, 33). According to these first systematic studies in animal paleopathology, it was concluded, that arthropathies was a commonly observed condition in the working animals, such as draught cattle and horses. This phenomenon was explained by mechanical stress

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(common in working animals), as a one of the most important predisposing factor that can lead to osteoarthropathies. This was probably the crucial point in joint anomalies interpretation in animal paleopathology.

The development of new diagnostic methods and procedures in modern veterinary medicine allows for the possibility of numerous etiopathogenic factors analysis, which are responsible for many disorders of the skeletal system of animals. In fundamental pathology, "new" joint diseases descriptions can be found, thus forming a separate clinical entity in veterinary medicine. Literature data from animal paleopathology is mainly focused on interpretation and recording methodologies of osteoarthropathies (10, 15).

In respect to similar investigations, the aim of this paper is to describe joint diseases recorded in paleopathology, using the classification and nomenclature methods of fundamental veterinary pathology (12, 31).

CLASSIFICATION OF OSTEOARTHROPATHIES IN ANIMAL PALEOPATHOLOGY

There is no complete classification of anomalies in veterinary pathology. The same conclusion can be made for joint diseases, but in the case of paleopathology, there are several other complicating factors. Diagnostic methods in paleopathology are often limited to gross examination (paleoradiological and histopathological investigations were described in some surveys) of animal bone materials revealed during archaeological explorations. In most cases, analysis is performed on fragmented skeletal components, because whole and complete animal skeletons are a rarity (15, 26, 27). Moreover, many paleopathologists are not professional veterinarians or veterinary pathologists, which significantly limit their ability for correct identification, description, diagnosis and interpretation of the observed pathological changes. The most important factor is the many differences and inconsequences in the nomenclature of pathological conditions that can be found in the veterinary pathology textbooks. Namely, these textbooks are the source material for paleopathological diagnosis. Finally, the last factor is the lack of abnormalities classification in paleopathology. All these factors can lead to misdiagnosis and wrong interpretation of pathomorphological lesions in osteological animal remains.

The best way to recognize the significance and nature of the disease process is to apply a systematic approach to the pathological conditions. It is necessary to localize and describe pathological changes and develop a list of etiological factors (cause-result relation) and differential diagnosis. This reduces the possibility of mistakes in diagnosis, but it is essential to have correct classification with systematization of nomenclature in paleopathology. Some attempts for professional description and typisation of animal paleopathologies can be indicated in the available literature (2, 3, 4, 16).

Osteoarthropathies are one of the most commonly studied aspects of animal paleopathology (14, 15, 24, 32). It was stated that joint diseases are the most prevalent pathological changes in cattle remains (14, 32). Nevertheless, changes in the joints are also described in the skeletal remains of dogs (32), sheep/goat (2,3), pigs and some birds (3).

On the basis of anatomical localization, pathological processes can affect joints of the axial and appendicular skeleton, but depending on the type of joint some changes can be localized in various parts of the joints (12, 31). In this review we present a classification of joint diseases according to general veterinary pathology:

1. Developmental diseases of joints
2. Degenerative diseases of joints
3. Inflammatory diseases of joints
4. Traumatic diseases of joints
5. Tumors and tumor-like lesions of joints

1. Developmental diseases of joints

Developmental abnormalities of joints and bones are less frequently detected in bone animal remains than in other acquired pathological changes. Regardless, in order to facilitate the better understanding of the complexity in arthropathology, we shall show here only those anomalies that can be detected in archaeofauna. Etiology is the same as for the development of diseases in other organs, namely: unknown, multifactorial, monogenic, chromosomal and teratogenic. A great number of developing joint diseases are known in pathology: osteochondrosis (eg. hip dysplasia), developmental dislocations/subluxations, arthrogryposis, congenital torticollis, etc. (12, 31).

The best example of developmental abnormalities of the joints is canine hip dysplasia, also diagnosed in horses and cattle. The disease has polygenetic and multifactorial etiology with influence of the environmental factors. Clinical symptoms usually affect older dogs of large dog breeds. The changes start with synovitis and erosions on the articular cartilage. The femur head loses the

round contour, creating severe degeneration of the articular surfaces with periarticular exostoses. The acetabulum is shallow and fills new osseous mass. The neck of the femur is wider than usual due to the new-created osteophytes. In palaeopathology, data on hip dysplasia is scarce, but this condition is expected to be found in the bones of dogs (23).

Another example of developmental anomalies of the joints is osteochondrosis. It is a frequent osteoarthropathy of pigs, horses and large dog's breeds. Cattle and sheep are rarely affected. Young and fast growing animals are predisposed to it. It occurs due to the disorders of endochondral ossification. Synonyms for this disorder are *osteochondritis dissecans* and *osteochondrosis dissecans*. The primary lesion occurs in the articular surface and is characterized by aseptic degradation of the articular cartilage and subchondral bone. Macromorphological diagnosis of osteochondrosis is difficult, because it needs well-preserved osteological material. Taphonomical changes and osteoarthritis can hinder the diagnosis of this pathology (24). The insertions in the articular surface can be found due to defragmentation of the subchondral bone. Osteochondrosis is common in palaeopathology, but it is often the cause of degenerative osteoarthropathies which have much more pronounced changes. However, Sapir-Hen et al. (28) claim to have diagnosed osteochondrosis in talus of cattle from the archaeological site of Tel Megadim, Israel. Y. Telldahl (30) reports, that the articular depressions may be a sign of osteochondrosis or *osteochondritis dissecans*. However, articular depressions have often been seen in animal bone remains. According to Baker and Brothwell (2), articular depressions occurs in 7-13% of cases of all pathological changes. Earlier, it was believed, that the articular depressions are not pathological changes. It is easy to diagnose these changes. Noticeably, there are different types of incissions on articular facets and it is obvious, that the changes are identical to those in osteochondrosis of the joints.

2. Degenerative diseases of joints

Osteoarthritis (degenerative osteoarthritis, degenerative joint disease, degenerative osteoarthropathy) is an abnormal condition of the joints, which is paleopathologically characterized by: grooving on the articular surface, eburnation, extension of the articular surface and peripheral exostoses (Fig. 1) (2).

These are the accepted criteria for diagnosis of osteoarthritis in paleopathology. As previously mentioned, the great number of findings indicates this disease of the joints. The pathological image

of lesions in the joint depends on the period of process development. Based on the etiological and pathological aspects of this joint pathology, there is a primary and secondary osteoarthritis. Primary osteoarthritis can develop in cases when there are no external predisposing factors that can lead to disease. Aging is the only predisposing factor that leads to primary osteoarthritis in animals, thus it is possible to question this kind of change when we observe archaeozoological material. Reduced blood flow in the joints of the animals leads to ischemic necrosis of the cartilage, which is the initial factor for further degenerative change (31).

Secondary osteoarthritis is the consequence of a developmental disease of the joints (osteochondrosis) or, more frequently, some exogenous predisposing factors (trauma, physical burdening), which directly influence the formation of lesions within the articular cartilage. Traumatic changes, eg. impact in the joint region, can lead to instability, which causes degenerative lesions in cartilage. Necrosis, fractures, metabolic diseases of the joints, septic arthritis are changes which can cause secondary degenerative joint diseases (31).



Figure 1. Osteoarthritis (spavin) of the tarso-metatarsal joint in cattle from Sirmium (Late Antiquity), Serbia (22)

Morphological changes in the joints are identical, regardless the primary or secondary osteoarthritis. The primary changes are the erosion of the cartilage in those parts of the articular surface where the highest load bearing occurs. Articular cartilage is ulcerative, rough and macroscopically there is visible fibrillation. Linear-grooves on the articular surface, as a result of fibrillation, are seen most commonly in horses. The pathological process is extending to the subchondral bone that suffers sclerosing changes causing eburnation. In some rarer cases (due to eburnation) subchondral formation of cysts can be formed (24). Finally, after 7 days in the margin of articular surface exostoses can be seen (12, 31). Marginal osteophytes or exostoses are of different size, depending on the period of the occurrence of the process. Sclerosis of the subchondral bone may be the initial lesion in degenerative joint disease. However, the whole process is ending with extension of the articular surface. All described changes can be found on the skeletal remains of animals and almost always point to osteoarthritis.

Osteoarthritis in paleopathology is common, especially in cattle and horses, which was concluded on the basis of the observations of many authors (4, 10, 11). This is a pathology of “working” animals. According to Baker and Brothwell (2), the first archaeozoological reports from the nineteenth and twentieth centuries have pointed to the high prevalence of osteoarthritis in horses and cattle. Constant exploitation is the main explanation in archaeozoology used for this interpretation (2, 3, 14, 26). Bartosiewicz et al. (4) stated that joint pathology in cattle is the best “indicator” of exploitation on the basis of the similarities between the pathomorphological changes observed in cattle skeletal remains and modern Romanian draught oxen abnormalities.

Also, Bartosiewicz et al. (3, 4) had provided a comparative analysis of the osteological material, especially on metapodial bones and phalanges, in cattle from the Roman period and the Middle Ages with the same bone remains of prehistoric cattle. Lesions of the bones and joints in metapodials and phalanges occurred more often in cattle from the Roman period and the Middle Ages. This can be explained by the increased use of the animal species by man in the later period, as it was during the development of agriculture in ancient World civilizations (Roman Empire) and later, in medieval times. The systematic conducted survey of distal skeletal elements of bovine limbs remains from Eketorp (Sweden) has shown that there are no major changes in the prevalence of pathological lesions

between animals of the Iron Age and the Middle Ages (30). However, the most prevalent degenerative joint diseases that can be found in archaeozoological material are bone spavin and ring bone (Fig. 2) in horses and cattle. The etiology of the bone spavin and ring bone is similar to osteoarthritis generally. Rather, there is almost no paleopathological survey in which this joint abnormalities are not described. What is interesting is the fact that bone spavin and ring bone even today have a high clinical importance in veterinary orthopedy of sport horses.



Figure 2. Proximal exostoses and lipping observed on phalanx prima from Sirmium - ringbone (Late Antiquity), Serbia (22)

Spondylitis chronica deformans is a degenerative disease of joints characterized by a fusion of the vertebrae (Fig. 3). Modern veterinary medicine knows many degenerative diseases of the spine (disc protrusion, fibrocartilage embolism), which can not be diagnosed in the dry bones from archaeological sites. Spondylitis is given special attention in paleopathology. This disease occurs in all domestic animals, but higher prevalence of occurrence of the disease was observed in older dogs (31). The exact cause of the disease is unknown, but traumatic lesions of *nucleus pulposus* have a crucial importance for the etiopathogenesis of spondylitis (12, 31). It is interesting that the skeletal remains of spondylitis or spondylitis, in the form of osteophyte formation, are usually diagnosed in horse remains. A wide range of “back problems” is observed in horse’s remains, too. Paleopathology has revealed

that spondylosis in horses occurs most likely due to over-riding or when using an improper saddle (5, 17, 19). The “kissing spine syndrome” as a fusion of 17 vertebrae in the spinal remains in the so-called “shaman” horse was described by Bökönyi (6). Bartosiewicz and Bartosiewicz (5) reported a severe form of spondylosis in the spine of the Migration period horse from the necropolis located in Hungary. This was a very severe case, maybe a terminal stage of spondylotic process, which authors compared with Bechterev’s diseases in humans. According to that, the frequent reports of vertebral fusion in animal paleopathology in the majority of the cases could be interpreted as a result of spine overloading and improper utilization of young animals (17, 29).



Figure 3. Vertebral column pathologies of horse – fusion of T18 – L1 vertebrae. Unpublished material from Caričin Grad (*Justiniana Prima*), early Byzantine period, Serbia

3. Inflammatory diseases in joints

Inflammatory diseases or inflammations of the joints in the literature cited below are synonyms for arthritis and synovitis (12, 31). It should be stated that the inflammatory process is not the same as the infectious process - in this case arthritis. Secondary inflammation is a common alteration in degenerative joint diseases - osteoarthritis, which in many cases can make a diagnosis difficult. Following this fact, inflammatory diseases of joints can be divided into: infective - with the presence of infectious microorganisms, and non - infective with the absence of microorganisms.

Many biological agents, including bacteria, viruses and fungi can be the cause of infectious arthritis of domestic animals. Septic arthritis caused

by bacteria is common (in contrast to viruses or fungi) in large and slaughter animals as a sequel of septicemia. Therefore many bacterial species can become a cause of arthritis. Probably the most important are pyogenic bacteria such as: *Arcanobacter pyogenes*, *Staphylococcus aureus*, *Streptococcus spp.*, *Actinobacillus spp.* etc. *Salmonella spp.*, *Escherichia coli*, *Mycoplasma spp.*, *Brucella spp.*, *Erysipelotrix rhusiopathie*, *Klebsiella spp.* can cause a joint infection in domestic animals (31), but species determination of bacteria in bone lesions from animal remains was not reported.

Animal skeletal remains of disarticulated joints had shown the sign of infection (2, 3, 24). According to the literature, in one study, 30% of the phalanges originating from cattle (Viking Age) showed destruction of the articular surface, which may be the result of infection (24). Baker and Brothwell (2) report a number of cases of joints infection (axial and appendicular skeleton) in all domestic animals, mostly among the remains from the British sites. Osteolytic changes in the form of cavitation and sinuses are a sign of suppurative processes (abscesses) within bone tissues. Degradation of the articular surface with the periosteal reaction and the formation of marginal osteophytes are also present in articular infection. Articular extension and eburnation are rare findings in cases of joint infection. Irregular bone proliferation can lead to complete joint ankylosis. Such terminal pathological changes detected in tibia, talus, calcaneus, tarsal and metatarsal bones horse from Nitra – Chrenova site (Slovakia) (Fig. 4) are one of the most advanced joint and bone infections documented recently in animal paleopathology (15). The osteolytic changes were diagnosed in the distal phalanx of sheep and cattle, which are characteristic for footrot (2).



Figure 4. Infection of horse tarsal joint from Roman period, Nitra-Chrenova site, Slovakia (15)

Aseptic arthritis occurs without the involvement of microorganisms. A typical example is the rheumatoid arthritis in dogs and cats. Unfortunately, the accessible literature lacks any reports on animal bone assemblage from archaeological sites, because of the macroscopic differential diagnosis difficulties.

4. Traumatic diseases of joints

The most important traumatic injuries of the joints are *distorsio*, *luxatio* and *subluxatio*. According to the clinical status, they are divided into acute and chronic traumatic osteoarthropathy. The causes and archaeological significance of traumatic joints injuries of the joints are identical to those of bone trauma (2, 3). Traumatic joints injuries in paleopathological surveys have been observed (2). Some changes, dislocations/subluxations are difficult to distinguish from degenerative osteoarthritis or from some stages of degenerative joint disease (24). Spectacular post-traumatic changes are observed in sites dating from the Roman Republic and the Roman Empire. It is clear, that traumas of the skeletal system were caused by human intentional activities, Roman sports like chariots racing (22, 26).

5. Tumors and tumor-like lesions of joints

Neoplasms or tumors of joints are rare in archaeozoological findings. As with other bone tumors, macroscopic diagnosis and differential diagnosis of certain joint tumours types is almost impossible on the basis of unearthed animal bones. Paleopathological reports on these joint changes in animals are scarce, but some neoplastic alterations were found in dog skeletal remains. Onar et al. (25) described tumor in dog's humerus coming from Urartian fortress Van Yoncatepe. The tumor was described in the pelvis of the sacrificed monkey from Tuna El-Gebel (Egypt) by Angela von den Driesch et al. (33). The latter work formed a source of many arthropathies proofs, which were interpreted as results of traumas, hypovitaminosis (vitamine D metabolism disorder because of lack of sunlight) and technopathies (33).

CONCLUSION

Osteoarthropathies belong to the most frequent pathological conditions, which can be detected on animal skeletal remains. The most common joint defects are degenerative changes, which may be a sign of the intense use of animals by human populations in the past. According to the available literature (2, 3) and the authors' experiences in this field, it can be concluded that the ethiopathogenic factors that lead to osteoarthropathies are complex

and multifactorial. In cases of paleopathological surveys, it is preferred that joint malformations undergo paleoradiological and histological analysis. These techniques can confirm macroscopic diagnosis, which is in some cases subjective. This paper applied the classification and systematization of fundamental pathology of joint disease. These methods of classification can in certain circumstances be applied in animal paleopathology.

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