Morphological finding of a large osteochondral defect of the trochlea tali in a foal – a case report

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Abstract

Septic arthritis is the most common result of the passive transfer failure (PTF) of immunoglobulins in foals. Immunoglobulins G play an important role in foal immunity, and they are the first mechanism of protective humoral immunity. In our report, we documented a morphological finding of the PTF in a 16-day-old colt foal admitted at the Equine Clinic with onset of septic arthritis of the right tarsal joint. Due to a bad prognosis even for pasture soundness despite arthritis therapy and antibody supplementation, we decided for euthanasia. Necropsy of the limb revealed a huge osteochondral defect in the lateral talar ridge, which extended into the adjacent bone tissue.

IgG, osteolysis, passive transfer failure, regeneration, septic arthritis

The diffuse epitheliochorial placenta of the mare is impermeable to maternal antibodies – immunoglobulins (Jeffcott 1974). Agammaglobulinaemic new-born foal is dependent on maternal protective immunoglobulins G (IgG) only from maternal colostrum during the first 24 h, when specific receptors on enterocytes in the small intestine are open for the passage of IgG molecules (McGuire and Crawford 1973; de Sobral et al. 2021; Reiter and Reed 2023).

In the case of insufficient uptake and resorption of maternal IgG by enterocytes, within 8–24 h after parturition, this condition is referred to as passive transfer failure (PTF) of IgG. In the case of PTF, the aetiology is very broad, from premature lactation, insufficient maternal nutrition, maternal stress and low IgG concentration in colostrum to foal stress, weakness or illness that can lead to inadequate intake of colostrum, or poor intestinal absorption of ingested IgG and others (Morris et al. 1985; Franco Ayala and Oliver-Espinosa 2016). The consequence of PTF is the development of inflammatory diseases caused by insufficient protective humoral immunity of the foal. The most common consequences of PTF include sepsis, bacterial meningoencephalitis, pneumonia and pleuropneumonia, omphalopathies and, among others, also septic arthritis (Taylor 2015; Oberkersch et al. 2022).

Septic arthritis (SA) is a secondary inflammation of the synovial joints that occurs by haematogenous dissemination of Gram-negative and Gram-positive bacteria in foals with PTF (Annear et al. 2011; Glass and Watts 2017). The efficient spread of bacteria is also aided by the nature of neonatal vascularization of the synovial membrane, subchondral bone, and epiphysis. This vascularization is very dense in neonates, and its haemodynamic conditions provide a good environment for bacterial colonisation (Annear et al. 2011). If SA therapy is to be effective and successful, it must be initiated as early as possible. For the treatment of SA, a combination of systemic antibiotics and nonsteroidal anti-inflammatory drugs is used, with the combined application of intra-articular antibiotics and joint lavage. Debridement of necrotic bone tissue is performed in order to remove

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the infectious nidus, which is a constant source of bacteria and associated infection (Neil et al. 2010).

Case presentation

Management and therapy

A 10-day-old Dutch Warmblood foal was admitted to the Equine Clinic due to swelling, increased local temperature, and effusion of the right tarsocrural joint, indicative of acute joint inflammation. Venous blood was collected for determination of IgG and inflammatory markers, including serum amyloid A (SAA). Laboratory tests were performed in a commercial laboratory (LABOKLIN GmbH, Bad Kissingen, Germany) (Table 1). The foal received systemic antimicrobial and anti-inflammatory therapy, as well as plasma supplementation for transfer of maternal antibodies and proteins. Joint lavage and intra-articular antimicrobial treatment were performed. Septic arthritis was suspected based on clinical, arthroscopic, and radiographic findings. Due to rapid deterioration and a poor prognosis, euthanasia was performed on the 16th day of life. Advanced diagnostic procedures, such as computed tomography were not performed. The primary aim of this case report was to document the postmortem morphological findings of an extensive osteochondral defect in a neonatal foal, rather than to evaluate therapeutic outcomes.

Table 1. Immunoglobulin G (IgG) and serum amyloid A (SAA) blood concentrations of the foal.

Marker	Value		Reference
	Before therapy	After therapy	
IgG	260 mg/dl	340 mg/dl	> 800 mg/dl
SAA	1,080.70 µl/ml	831.52 µl/ml	< 7

Postmortem findings

Necropsy of organ systems was without pathological findings; however, we observed a swelling and oedema of the periarticular subcutis and joint capsule. The internal surface of the joint cavity – synovial membrane was markedly thickened and hyperaemic. The joint cavity contained an increased volume of viscous, yellow-orange synovial fluid with fibrin clots. These changes reflect severe synovitis and support the presence of an active inflammatory intra-articular environment. The joint capsule and surrounding soft tissues were oedematous. On the lateral ridge of the trochlea tali, there was a large defect in the articular cartilage. Macroscopically, the affected articular cartilage had irregular margins and showed marked degenerative changes characterized by surface irregularity, softening and signs of chondronecrosis. This suggests a progressive degenerative and inflammatory process. The loss of normal cartilage architecture suggests prolonged exposure to inflammatory mediators and mechanical stress, leading to irreversible cartilage failure (Plate IV, Fig. 1). We did not observe any damage of the remaining articular cartilage on the rest of the affected ridge and on the medial ridge of the trochlea tali.

The affected joint was further macerated in sodium hydroxide (Mikrochem Trade spol. s.r.o., Pezinok, Slovakia) for approximately 2 weeks to visualize the bone tissue. Following maceration of the joint, a deep triangular defect extending into the bone tissue of the lateral ridge of talus was observed. The size of the defect was 35.80 × 37.13 × 17.15 mm and the depth varied from 5.89 to 9.57 mm. The subchondral bone plate was completely disrupted. The exposed bone tissue showed extensive osteolytic changes, including depletion, fragmentation, and loss of normal bone organization. These findings are consistent with an aggressive osteomyelitic process affecting the neonatal talus (Plate V, Fig 2 and Plate VI, Fig 3).

The remaining areas of the talus, including the medial trochlear ridge, as well as other bones of the tarsus and distal tibia, were fully ossified without macroscopic pathological changes. The findings document a localized, severe osteochondral defect associated with active intra-articular inflammation and subchondral and bone tissue involvement.

Discussion

Modern imaging modalities such as computed tomography (CT), scintigraphy and magnetic resonance (MR) are very useful for diagnostics of the joint and bone diseases. The higher sensitivity of these devices to detect cartilage damage, but also bone tissue, is crucial for faster application of therapy in foals. In general, higher sensitivity has been demonstrated for CT than for classical conventional radiography in the diagnosis of osteomyelitis, which is crucial for foals with sepsis (Lean et al. 2018). It is not only about showing the lesion, but also its better characterization, for example, the extent of the damage, bone loss, presence of abscesses and its size in all planes of sections (Ruocco et al. 2020; Lindegaard et al. 2021). The introduction of CT in neonatal practice for septic foals has been recommended as a gold standard by Ruocco et al. (2020) and Lindegaard et al. (2021). Modern diagnostic modalities such as CT/MR are also frequently used in neonatal practice, allowing for better access to foals. These include not only orthopaedic diseases, but also diseases of the respiratory system, teeth, head, neck, thorax and abdomen (Barba and Lepage 2013).

There are very few similar cases published in foals. One similar case of the osteochondral defect of the trochlea tali has been published in an adult horse. There was thickening and hyperaemia of the synovial membrane and exposure of the subchondral bone. Histopathological examination confirmed suppurative osteomyelitis with presence of neutrophil invasions, granulation tissue formation, and osteonecrosis (Amitrano et al. 2016). We assume that a similar histopathological finding would be present in our case.

Rhodococcus equi (*R. equi*) is a common pathogen that occurs in foals and causes pyogranulomatous pneumonia and septic arthritis or osteomyelitis (Glass and Watts 2017). Twelve foals manifested *R. equi* infection-caused osteomyelitis of different joints/ bones. Pathological examination revealed arthritis with necrobiotic changes of the articular cartilage, bone necrosis, osteomyelitis and bone lysis in 10 of 12 foals. Despite aggressive treatment with antibiotics and their combination and surgical intervention, 83.33% of foals infected with *R. equi* were euthanized due to a poor prognosis and extensive defects in cartilage and bone tissue (Ruocco et al. 2020).

In these cases, no details have been reported about the defects' dimensions and depth. The estimation of the dimension and evaluation of the cartilage and the real damage is important for possible treatment options. The unique nature of the cartilage, avascularity, hypocellularity and low mitotic activity predispose the cartilage to be an almost non-regenerative tissue (Bačenková et al. 2023). Likewise, bone tissue also has a limited regenerative capacity in critical bone tissue defects. Such defects can be treated by applying various scaffolds, autologous implants, xerotransplants and combinations of scaffolds, cells, biocements and biologically active molecules (Skierbiszewska et al. 2024). For example, self-repairable osteochondral defects in horses are those smaller than 9 mm on the medial femoral condyle (McIlwraith et al. 2011).

There are two studies dealing with osteochondral defect repair on the tarsocrural joint. Defects were made on the weight-bearing and non-weight-bearing surfaces of the trochlea tali ridges. In a 6.5 mm defect, cartilage healed more rapidly on the non-weight-bearing surface of the joint than on the weight-bearing proximomedial surface. However, the 6.5 mm defect healed only with fibrocartilaginous tissue, not with full-fledged hyaline cartilage (Fisher et al. 1986; Litzke et al. 2004). Similarly, small defects can be treated using innovative methods of regenerative medicine, applying various cements, scaffolds, and materials that are acellular or with a combination of cellular components (mesenchymal stem cells) and bioactive molecules (growth factors). Techniques used for cartilage regeneration include autologous application of chondrocytes, but also more modern techniques such as autologous implantation of chondrocytes on polymer carriers polyglactin/polydioxanone and polyetheretherketone (PEEK) with a combination of peptides (Barnewitz et al. 2006; Korthagen et al. 2019). This study brought promising results in the healing of articular cartilage and its integration into native cartilage (Barnewitz et al. 2006). In another study, an experimental application of PEEK material was performed using bioactive components – collagen mimetic peptides consisting of arginineglycine-aspartic acid and glycine-phenylalanine-hydroxyproline-glycine-glutamic acid-arginine. Based on histological evaluation, the defects appeared to be covered with cartilage tissue integrating with the original cartilage, however, the new cartilage showed weak staining intensity of glycosamine glycans and significant expression of collagen I. The bone tissue was well regenerated without any irregularities (Korthagen et al. 2019).

For both tissues (cartilage or bone) there are other very commonly used calcium phosphate cements. Calcium phosphates are the most natural to native bone in terms of their chemical structure and in terms of the Ca/P ratio to physiological bone of 1.5–1.67. Their osteoinductive and osteoconductive properties stimulate osteoblasts in the synthesis of new bone tissue. They also support the osteogenic differentiation of mesenchymal stem cells (Jeong et al. 2019). In a study conducted by Tsuzuki et al. (2012), a very good therapeutic effect of gelatine β-tricalcium phosphate with BMP-2 (bone morphogenetic protein 2) on the healing of bone defects (4.5 mm diameter × 27 mm deep) in the area of the third metacarpal bone in horses was demonstrated. After 16 weeks of the experiment, the authors concluded that the use of gelatine sponge with BMP-2 significantly accelerated the healing of bone tissue in the defects of metacarpal bone. Healing is accelerated by the gradual release of osteogenic growth factors and thus osteoinductivity is stimulated. These findings were confirmed by histological and radiographic analysis (Tsuzuki et al. 2012).

The main limitation of this case report is the absence of microbiological and cytological examination of the synovial fluid and the lack of histopathological evaluation of the affected tissues. Consequently, a definitive aetiological confirmation of septic arthritis was not possible. Nevertheless, the diagnosis was supported by hypogammaglobulinaemia, markedly elevated inflammatory markers, and extensive macroscopic inflammatory and destructive changes of the joint structures observed post mortem. The extent of cartilage and bone damage did not allow us to treat the patient conventionally, mainly to preserve joint function and patient welfare. It would be very interesting in the future to experimentally verify the effect of biomaterials on the treatment of large articular cartilage and subchondral bone defects in foals with septic arthritis due to PTF after appropriate and effective therapy of inflammation.

This case report primarily presents morphological documentation of an extremely extensive osteochondral defect of the trochlea tali in a new-born foal. The case report emphasizes the value of detailed postmortem examination in documenting pathologies and understanding the true extent of the defect, which may be one of the factors determining the applied therapy or choice of euthanasia in future cases. Interesting results might also be found in the future by comparing the extent of osteochondral defects detected intravitally by various diagnostic methods with possible postmortem findings in relation to the prognosis of the disease or the success of therapy.

Last but not least, pathological-anatomical findings are important for the production of teaching collections (anatomical preparations) and their use as a valuable educational resource for students and veterinarians in various morphological and clinical fields.

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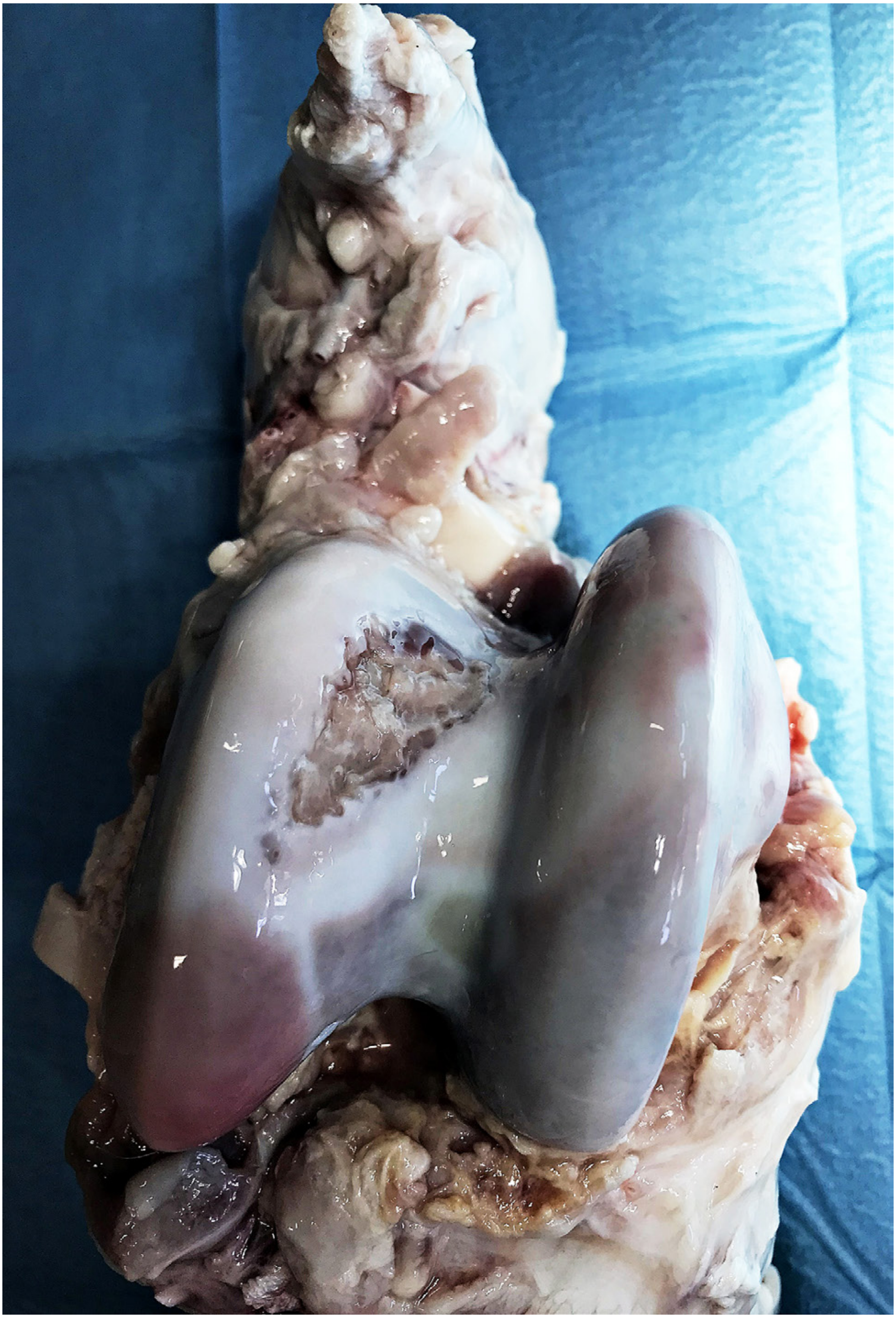

Fig. 1. Dorsal view on the triangular-shaped chondral defect of the lateral ridge of the trochlea tali. Severe chondromalacia and chondronecrosis are visible.

Fig. 2. Osteological specimen of the affected tarsal joint of a foal with an extensive triangular defect of the bone tissue of the lateral ridge of the trochlea tali.

Fig. 3. Detailed view on the triangular defect of the bone.