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Treatment of dog's osteoarthritis using autologous platelet-rich plasma

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Abstract. The relevance of this study arose from the rapid increase in cases of dog osteoarthritis affecting the knee joint. Clinically, this condition manifests as varying degrees of lameness, significantly diminishing the quality of life for affected animals. Therefore, the study aimed to evaluate changes in acute-phase inflammatory markers in the blood of dogs with osteoarthritis

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of the knee joint following intra-articular administration of autologous platelet-rich plasma. The diagnostic approach measured acute-phase C-reactive protein levels and erythrocyte sedimentation rate in blood samples. Tissue changes in the affected joint were examined through radiographic imaging conducted on the 1st day of plasma application and on the 90th day after the treatment course to assess the progression of reparative processes within the knee joint. Thus, it was established that by the 14th day following the final intra-articular injection of autologous platelet rich plasma, both the C-reactive protein levels and erythrocyte sedimentation rate in the blood exhibited a clear trend towards reduction, aligning with reference values. By the 21st day, recovery of these marker parameters to physiological ranges was observed in two out of five dogs, while the remaining three continued to show declining values. By the 90th day post-treatment, all five dogs displayed physiological values for the analysed markers. Radiographic findings before and after the course of cellular therapy indicated no further degenerative changes and a slight increase in joint space, demonstrating the effectiveness of autologous platelet-rich plasma in managing coxarthrosis in dogs. These findings hold significant practical value for both researchers and practising veterinarians, contributing to the refinement of treatment protocols for animals' osteoarthritis of the knee joint

Keywords: gonarthrosis; inflammation markers; C-reactive protein; erythrocyte sedimentation rate; radiography; cellular therapy

Introduction

Osteoarthritis is a degenerative joint disease that is frequently encountered in dogs. The prevalence of osteoarthritis, according to research by J. Graves *et al.* (2023), ranges from 2.5% to over 80%, depending on the diagnostic methods used in dogs. The disease, which clinically manifests as pain in the musculoskeletal system and varying degrees of lameness, is quite common in companion animals. V. Klymchuk (2021) noted that osteoarthritis affects up to 85% of large-breed dogs among those exhibiting chronic lameness.

According to research by B. Carr *et al.* (2024), osteoarthritis is a chronic degenerativedystrophic lesion of the joints. Among the characteristic features of this pathology, they noted a thinning of the articular cartilage (osteochondropathy) and its delamination (osteochondritis dissecans). At the same time, inflammation developed with damage to the meniscus (articular cartilage) and the rest of the anatomical structures of the knee joint, which caused the development of pain syndrome and loss of its functionality.

As noted by C. Pye *et al.* (2022), the primary problem in osteoarthritis is the destruction of articular cartilage. As a result, the cartilage loses its elasticity, thins, cracks, and undergoes fibrillation, affecting both its superficial and deeper layers, and eventually leading to delamination and exposure of the subchondral bone. The osteoarthritic process progresses to degeneration of the bone tissue surrounding the joint, loss of cartilage, abnormal bone formation beyond the joint (formation of osteophytes), and narrowing of the joint space. Scientists have established that joint diseases primarily affect geriatric animals, but in 20% of cases, the first symptoms of the pathological process appear at a young age.

S. Oh *et al.* (2023) found that the diagnosis of osteoarthritis of the knee joint involves various visual methods, including radiography, ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), arthroscopy, and analysis of changes in the composition of synovial fluid. According to T. Todosiuk *et al.* (2022), in Ukraine, radiography has been widely used among visual diagnostic methods for a more accurate analysis of the joint condition. Using this method, it is possible to detect such radiographic signs as narrowing of the joint space, the presence of osteophytes (osteophytosis), disruption of the configuration (deformation) of the articular surfaces (cracks, erosions), the presence of fragmentation of articular cartilage (so-called joint mice), and the presence of subchondral sclerosis.

N. Clark *et al.* (2023) developed a new clinical metrological device for detecting mobility impairments in dogs. The study results demonstrated that the device positively correlates with objective measures of canine mobility, considering the distribution of body weight on the animal's limbs, which allows for the detection of any minor changes in mobility. However, according to S. Oh *et al.* (2023), each of these methods has its advantages and disadvantages. Therefore, to monitor the inflammatory process, one of the visualisation methods and the study of acute-phase inflammation biomarkers in the blood is most often used. These biomarkers can be used as additional methods of laboratory analysis both at the stage of diagnosis and at the stage of monitoring the effectiveness of the treatment performed.

It should be noted that new and effective methods and treatments for osteoarthritis are being actively developed, which are more effective and significantly reduce the percentage of complications. In particular, in the studies of D. Pal *et al.* (2024), stem cells were used, B. Kurtulus *et al.* (2024) applied joint arthroplasty, and E. Gildea *et al.* (2024) indicated the feasibility of using injections of anti-NGF monoclonal antibodies. Scientists N. Blaga *et al.* (2024) conducted a pilot study of the application of intra-articular administration of autologous platelet-rich plasma for the treatment of pathological conditions in the joint area. The results of the studies indicate the advantages of this method of cell therapy among many others. However, the effectiveness of this method is being studied by various scientists to this day. Therefore, the research aimed to evaluate the efficacy of cellular therapy using autologous platelet-rich plasma for dog's knee osteoarthritis, focusing on quantitative changes in acute-phase C-reactive protein (CRP) levels and erythrocyte sedimentation rate in the blood.

Literature Review

Osteoarthritis is a condition commonly diagnosed in both human and veterinary medicine (Adams *et al.*, 2011; Coppola, 2024). As noted by these authors, this pathology is characterised by progressive degeneration and destruction of the joints, leading to impairments in their biomechanical function. The development of this disease is accompanied by significant pain and, sometimes, general wasting of the animal, which may be a result of systemic and local biomechanical factors. V. Klymchuk (2019) established that osteoarthritis of the knee joints, or gonarthrosis, is a chronic degenerative-dystrophic disease of the knee joints. The disease can occur in dogs due to many factors, including hip dysplasia, cruciate ligament pathologies, patellar luxation, knee injuries, obesity, nutritional deficiencies, inadequate physical exercise, and advanced stages of arthritis.

The research of K. Anderson *et al.* (2020) aimed to identify the etiological factors leading to pathological changes in joint tissues. The authors found that primary osteoarthritis is always idiopathic and may be associated with risk factors such as ageing and obesity in dogs.

The pathogenesis of secondary osteoarthritis has a genetic component that is exacerbated by lifestyle factors affecting the body, such as diet and exercise. P. Adams *et al.* (2011) noted that pathological processes and existing arthropathies can significantly influence the pathogenesis of osteoarthritis, for example, cruciate ligament disease is a common cause of lameness in the pelvic limbs of dogs regardless of their breed and size. As established by M. Weiwei *et al.* (2024), impaired blood supply to the joint leads to cartilage hypoxia, which can also be considered a potential pathogenic factor for osteoarthritis of the knee joint.

Regarding the diagnosis of osteoarthritis, P. Allen *et al.* (2019) found that it should occur in several stages. According to the authors, it is worth starting with an orthopaedic examination, during which the bones and joints are examined to identify pain reactions, tissue swelling, and the range of joint motion restriction. The second stage is the radiographic diagnosis, which can reveal changes such as bone growths around the joint associated with cartilage destruction, mineralisation of ligament attachments to bones, and the presence of fluid or swelling in the joint. By examining the synovial fluid, changes in leukocytes can be determined. Additionally, arthroscopy, MRI, CT, and bone scintigraphy are often used to differentiate the diagnosis. The authors believe that to diagnose osteoarthritis, a history of lameness must be established, as well as radiological evidence of pathology (damage to articular cartilage, reduced joint space) on orthogonal radiographs of the joints and asymmetry of gait between contralateral limbs ⩾ 6%.

According to A. Hillström *et al.* (2016), most patients with osteoarthritis do not exhibit characteristic changes in blood and urine test results, except in cases of diagnosed synovitis with significant effusion, where an increased ESR, hypoalbuminemia, and increased levels of acutephase markers such as CRP and fibrinogen may be detected. When examining synovial fluid, significant deviations from normal values are usually not found. A complete blood count can help diagnose signs of inflammation or infection. For example, CRP acts as a marker of inflammation in the body, regardless of the aetiology. Although osteoarthritis is not characterised by significant systemic inflammation, this test may be ordered to rule out other inflammatory conditions. A. Bertuglia *et al.* (2016) established that the ESR test is based on the principle that erythrocytes settle faster in the plasma of patients with acute inflammation, and therefore it has been used as a marker along with acute-phase proteins. Although ESR testing has been partially replaced by CRP and other marker tests, this indicator remains clinically useful, especially in the diagnosis and monitoring of rheumatic diseases and in predicting orthopaedic infections.

Regardless of the chosen treatment method for dogs with osteoarthritis, the primary goal is to reduce the animal's pain and slow the progression of pathological changes in the affected joint tissues. According to research by K. Anderson *et al.* (2020), after a diagnosis of osteoarthritis, animals are treated with medical or surgical therapy. Nonsteroidal anti-inflammatory drugs (NSAIDs) are the most commonly used group of analgesics. J. Carmona *et al.* (2016) noted that in recent years, autologous platelet-rich plasma, stem cells, and monoclonal antibodies have been used to treat animals with joint damage (Carreira *et al.,* 2024). For example, J. Catarino *et al.* (2020) established that platelet-rich plasma preparations are a common treatment for osteoarthritis in horses and other animal species. However, there is controversy regarding the ideal concentration of platelets and leukocytes in these biological substances, which is necessary to induce an adequate anti-inflammatory and anabolic response in articular cartilage. C. Pye *et al.* (2022) suggested that PRP treatment requires further standardisation and regulation of various methods. Larger controlled clinical trials are needed before definitive conclusions can be drawn about the effectiveness of this treatment method for dogs with osteoarthritis in practice.

Materials and Methods

The study was conducted from September 2023 to August 2024 at the scientific laboratories of the Faculty of Veterinary Medicine, the National University of Life and Environmental Sciences of Ukraine (Kyiv), and the "Shanty" Veterinary Clinic (Kyiv). The animal experiments adhered to Law of Ukraine No. 3447-IV "On the Protection of Animals from Cruelty" (2006), the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (1986), and Directive 2010/63/EU of the European Parliament on the protection of animals used for scientific purposes (2010).

The study involved five dogs diagnosed with osteoarthritis: Ares, a three-year-old male Central Asian Shepherd weighing 60 kg; Brooklyn, a ten-year-old male Basenji weighing 9 kg; Rodos, a thirteen-year-old male Staffordshire Terrier weighing 25 kg; Dorian, an eleven-year-old male Labrador weighing 30 kg; and Grey, a ten-year-old male Cane Corso weighing 45 kg. All animals underwent clinical examinations and clinical-instrumental assessments. The clinical examination included anamnesis collection, general inspection, and orthopaedic testing (e.g., the cranial drawer test and compression test) to rule out cranial cruciate ligament rupture. Additionally, the dogs' gait was evaluated for signs of lameness, stiffness, and difficulty in changing body positions.

Blood for obtaining autologous platelet-rich plasma was collected from the jugular vein of dogs at a volume of 9.0 mL per animal. Sodium citrate was used as an anticoagulant at a ratio of 1:9. A two-step centrifugation method using a Hettich EBA 200 centrifuge (Andreas Hettich GmbH, Germany) was employed to obtain PRP. The first centrifugation was performed at a centrifugal force of 160 g (1,500 rpm) for 7 minutes. Platelet-rich plasma was collected. The platelet-rich plasma suspension was centrifuged again at a centrifugal force of 500 g (4,000 rpm) for 10 minutes. The supernatant was removed, leaving 0.4 mL of plasma and a platelet pellet at the bottom of the tube. The platelet concentration in the obtained plasma was within the range of $1{,}150\text{-}1{,}250 \cdot 10^3$. Platelet-rich plasma was administered to the experimental animals into the affected knee joint using intra-articular injection, adhering to aseptic and antiseptic techniques. This procedure was performed under general anaesthesia.

The general anaesthesia protocol was as follows: an aesthetic mixture of Domitor Vet (medetomidine hydrochloride 1 mg/mL) at a dose of 0.01 mg/kg and Butomidor (Butorphanol), 10 mg/mL at a dose of 0.1 mg/kg body weight was administered intramuscularly (Orion Pharma, Finland). The animals were monitored under anaesthesia using clinical methods and the InnoCareVet device (Hungary), which determined heart rate, respiratory rate, blood oxygen saturation, rectal temperature, and arterial blood pressure (measured using a cuff on the brachial region in automatic mode). To determine the effectiveness of autologous platelet-rich plasma, the dynamics of changes in the knee joint before and after the administration of the drug were assessed by examining blood parameters such as ESR and CRP, as well as radiographic examination before the start of treatment and 90 days after the last administration of the drug.

ESR was determined using the Panchenkov method (Malin & Witkowska-Piłaszewicz, 2022). Capillary blood was collected from the ear pinna and mixed with a 5% sodium citrate solution at a ratio of 1:4. The stabilised blood was drawn into a graduated tube to the 0 mark and placed vertically in a rack. The ESR was determined after one hour by measuring the height of the plasma column above the blood sediment (in mm). CRP levels in serum were measured using the Vcheck V200 kit (BioNote, Korea), which is based on a fluorescent enzyme immunoassay for measuring the concentration of this acute-phase protein.

Radiographic examinations were performed in two projections (ventrodorsal and mediolateral) at the Veterinary Radiology and Radiodiagnosis teaching laboratory of the Department of Therapy and Clinical Diagnostics, Faculty of Veterinary Medicine, National University of Life and Environmental Sciences of Ukraine, using a VATEL-1 X-ray machine (Ukraine), with a maximum accelerating voltage of 90 kV. Based on the diagnostic methods used and the results obtained, 5 dogs were selected with a diagnosis of osteoarthritis. Statistical analysis of the obtained results was performed using the Statistica 5.0 software package (StatSoft Inc., USA), taking into account the Student's t-test for normally distributed data. Differences were considered statistically significant at $P < 0.05$.

Results and Discussion

A clinical examination and instrumental investigation were conducted on 998 dogs whose owners sought veterinary care due to musculoskeletal problems. The total number of dogs in which locomotor disorders were detected (based on the research institution) is presented in Figure 1.

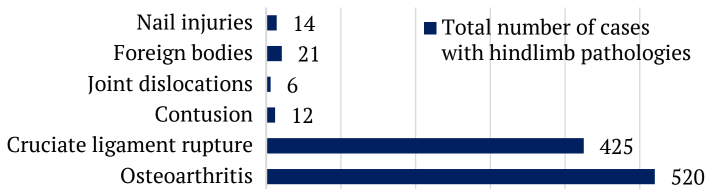


Figure 1. Total number of dogs in which locomotor disorders were detected (based on a veterinary clinic in Kyiv)

Note: *shows the number (prevalence) of different musculoskeletal disorders in animals that were diagnosed during clinical examination and as a result of instrumental examination of animals*

Source: *authors' development*

Osteoarthritis was recorded in 52% of the examined dogs; cruciate ligament rupture was diagnosed in 43% of animals; contusions of varying severity were found in 1.2% of dogs; joint dislocation and foreign bodies (osteophytes, joint mice) were found in 0.6% and 2% of cases, respectively. A. Cohen (2024) found that injuries to the knee joint, which can lead to cruciate ligament rupture or osteochondrosis, are the most common factors in the development of osteoarthritis. These are classified as secondary orthopaedic diseases. However, joint tissue wear can also be a cause of this pathology. P. Adams *et al.* (2011) found in their studies that overweight animals are at risk of developing various diseases in the knee joint. For example, dogs with obesity are four times more likely to be diagnosed with complete or partial cruciate ligament ruptures compared to animals with a normal weight. K. Anderson *et al.* (2020) suggested that a genetic factor, which primarily affects the growth and development of the musculoskeletal system in dogs, is also a cause of the development of pathologies in various tissues in the joint area.

All dogs in the study exhibiting joint pathology demonstrated signs of pain upon clinical examination. Pain was observed in some cases at rest, while in others it was elicited by passive movement of the limb or palpation of the joint and periarticular tissues. Monitoring the dynamics of this symptom is a valuable indicator for assessing the effectiveness of treatment. Difficulty in rising and lameness, which varied in severity and duration, were also observed in animals with complaints about the musculoskeletal system. In the study dogs, lameness typically varied throughout the day. It occurred when the animal transitioned from a state of rest (lying or sitting) to movement (starting lameness), worsened with physical exertion, and prolonged after exercise. In one-third of the examined dogs, crepitus and crackling were heard during passive movements of the affected joint. J. Catarino *et al.* (2020) indicated that damage to intra-articular tissues specifically caused inflammation and ultimately led to erosion of the protective cartilage layer in the joint. The articular surface of the bone becomes exposed as the cartilage wears away, resulting in a lack of shock absorption in the joint. The inner lining of the joint capsule, which surrounds the joint, reacts with inflammation in the form of synovitis and, eventually, fibrosis (scar formation).

Arthroscopy of the affected joint (Fig. 2) provided more precise data on the structural changes present in the articular cartilage and other joint structures: destructive and proliferative changes in bone tissue and inflammatory processes. The obtained data coincide with the data of other researchers. For example, S. Oh *et al.* (2024) noted that the joint capsule produces synovial fluid, which lubricates the joint and supports the health of cartilage, ligaments, and structures within the joint. As the joint capsule becomes inflamed and fibrotic, the synovial fluid becomes thin and watery, increasing friction between the articular surfaces of the bones and reducing joint cushioning. Pain from osteoarthritis is associated with cartilage damage, exposed bone, friction, bone changes, and inflammation in the joint. As a result of the joint puncture (Fig. 3), the following changes were found after a visual examination of the obtained synovial fluid. In a healthy joint, the synovia is light yellow, clear, and free of crystals.

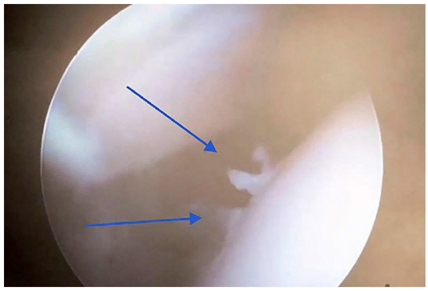


Figure 2. Visualisation of the joint cavity during arthroscopy

Note: *arrows indicate detected defects in the cartilage surfaces of the articular ends of the bones in the knee joint of the affected limb of the dog*

Source: *authors' photo*

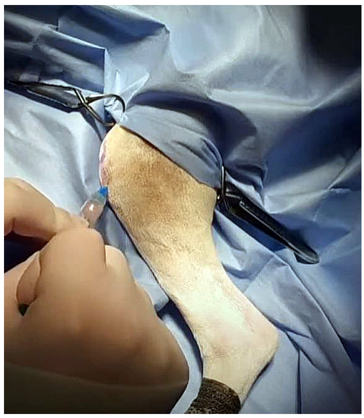


Figure 3. Arthrocentesis of the knee joint in a dog

Note: *the knee joint was aspirated to collect synovial fluid for further analysis*

Source: *authors' photo*

In animals with knee joint pathologies, a change in the transparency of the synovial fluid was noted, ranging from semi-transparent to turbid or intensely cloudy. In dogs with knee contusions, the synovial fluid contained blood. According to research by J. Graves *et al.* (2023), studies of joint fluid from arthritic joints revealed an increase in leukocytes. The dynamics of the diseased joint were assessed using radiography (Fig. 4), which was performed twice in animals selected for treatment using autologous platelet-rich plasma.

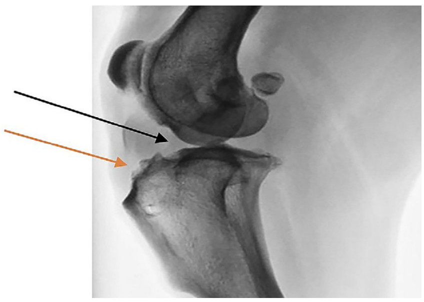


Figure 4. Radiographic signs of osteoarthritis in the canine knee joint

Note: *the black arrow indicates the narrowing of the joint space, the orange arrow – changes in the articular margin of the tibia*

Source: *author's photo*

After confirming the diagnosis of osteoarthritis of the knee joint in the animals, five dogs were selected, whose owners agreed to treatment using autologous platelet-rich plasma. Example 1. Ares, a 3-year-old male Central Asian Shepherd weighing 60 kg, is housed in a kennel. The owner reported that for the past two months, the dog had exhibited moderate lameness and stiffness, which began after a fight with another dog. A wound in the knee joint area preceded the joint pathology. Clinical examination revealed lameness in the left pelvic limb and stiffness in the knee joint.

Example 2. Brooklyn, a 10-year-old male Basenji weighing 9 kg, is housed in the owner's home. The owner reported that for the past year, the dog had exhibited stiffness, reluctance to exercise, and difficulty rising from a sitting or lying position. The dog also avoided stairs. On clinical examination, stiffness, reluctance to jump over obstacles, and an elevated temperature of 39.3°C were noted. The owner was advised to have the dog further investigated to determine the underlying cause of these symptoms.

Example 3. Rodos, a 13-year-old male Staffordshire Terrier weighing 25 kg, is housed in the owner's home. The owner reported that for the past year, the dog had exhibited stiffness, reluctance to exercise, and an unwillingness to climb or descend stairs. Over the past week, the lameness had worsened. On examination, mixed-type lameness in the left pelvic limb and stiffness in the knee joint were noted. The owners reported that the dog had previously been given dietary supplements containing collagen, chondroitin, and glucosamine, but there had been no improvement in the overall condition.

Example 4. Dorian, an 11-year-old male Labrador Retriever weighing 30 kg, is housed in the owner's home. The owner reported that for the past year, the dog had exhibited stiffness, reluctance to exercise, and particularly severe lameness over the past week. The dog also refused to go for walks longer than 20 minutes, during which it would take frequent breaks. On clinical examination, lameness in the left pelvic limb and stiffness in the knee joint were noted.

Example 5. Grey, a 10-year-old male Cane Corso weighing 45 kg, is housed in a kennel. The owner reported that for the past year, the dog had exhibited stiffness, reluctance to exercise, and particularly severe lameness for the past two months. Initially, the owner had treated the dog with non-steroidal anti-inflammatory drugs in combination with vitamin and mineral supplements, but the condition did not improve and gastritis developed during treatment. Consequently, the owner discontinued treatment. On clinical examination, lameness in the left pelvic limb and stiffness in the knee joint with crepitus during passive movement were noted. Radiographs taken before treatment (Fig. 5) showed a narrowing of the joint space and a disruption of the articular surface of the tibial epiphysis in all examined animals. In dog number 4, pre-treatment radiographs revealed medial narrowing of the joint space, consistent with stage 2-3 osteoarthritis of the knee joint (Fig. 6).

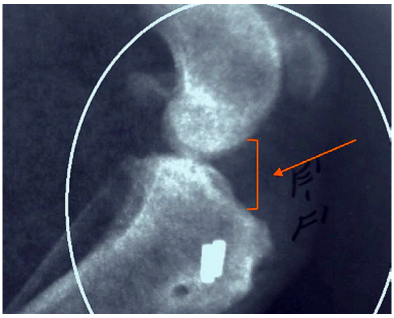


Figure 5. Radiograph of osteoarthritis in the knee joint of dog number 1 before treatment

Note: *mediolateral projection of the affected knee joint of dog number 1 before treatment. The arrow indicates the narrowing of the joint space*

Source: *authors' photo*

Figure 6. Radiograph of osteoarthritis in the knee joint of dog number 4 before treatment

Note: *mediolateral projection of the affected knee joint of dog number 4 before treatment. The arrow indicates the narrowing of the joint space*

Source: *authors' photo*

Radiographic examinations performed three months after the start of treatment (Fig. 7, 8) showed an absence of further degenerative changes and a slight increase in the joint space.

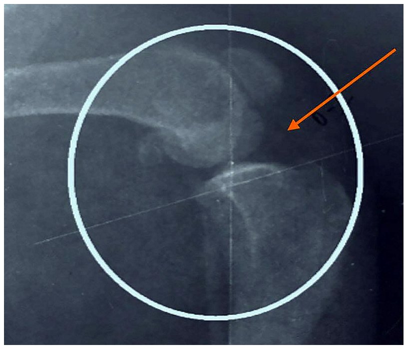


Figure 7. Radiograph of osteoarthritis in the knee joint of dog number 1 three months after treatment

Note: *mediolateral projection of the affected knee joint of dog number 1 three months after treatment. The arrow indicates the widening of the joint space*

Source: *authors' photo*

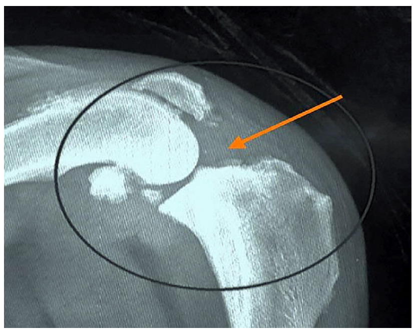
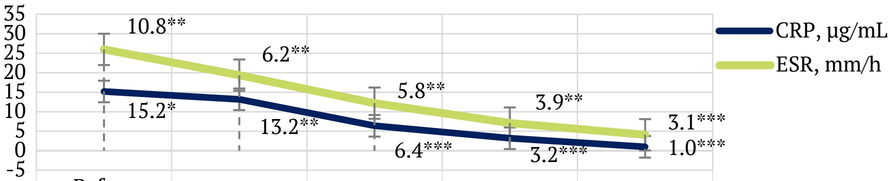


Figure 8. Radiograph of osteoarthritis in the knee joint of dog number 4 three months after treatment

Note: *mediolateral projection of the affected knee joint of dog number 4 three months after treatment. The arrow indicates the widening of the joint space*

Source: *authors' photo*

Following a course of treatment consisting of three intra-articular injections of 0.8 mL of autologous platelet-rich plasma per injection, the study animals exhibited increased activity, absence of lameness, and a reduction or complete absence of pain. Pre-treatment analysis of complete blood counts revealed elevated ESR and CRP levels. Post-treatment, a decrease in ESR to reference values and a reduction in CRP levels to 1 µg/mL, which was at the upper limit of the reference range, was recorded (Fig. 9).



	Before treatment	Day 7	Day 14	Day 21	Day 90
ESR, mm/h	10.8	6.2	5.8	3.9	3.1
CRP, µg/mL	15.2	13.2	6.4	3.2	1.0

Figure 9. Changes in ESR and CRP levels in dogs (M ± m, n = 5)

Note: *the blue line represents the dynamics of C-reactive protein changes, the orange line – the dynamics of erythrocyte sedimentation rate changes. *P < 0.05; **P < 0.01; ***P < 0.001*

Source: *authors' development*

Figure 9 illustrates the dynamic changes in ESR and CRP levels in dogs, providing evidence for the efficacy of platelet-rich plasma therapy in treating canine osteoarthritis. Results from complete blood counts showed a significant decrease of 42.6% (P < 0.001) in ESR and 15.6% (P < 0.001) in CRP levels compared to pre-treatment values. The 90 days post-treatment, ESR and CRP levels had further decreased by 71.3% (P < 0.001) and 93.5% (P < 0.001), respectively, relative to baseline values. These findings suggest a marked reduction in systemic inflammation in the treated dogs.

K. Malin & O. Witkowska-Piłaszewicz (2022) noted that acute-phase response biomarkers are not specific to osteoarthritis. In animals with this condition, hyperglobulinemia is observed, leading to a significant increase in ESR and elevated levels of acute-phase reactants such as CRP and fibrinogen. C-reactive protein, as highlighted by K. Hurter *et al.* (2005), is one of the most commonly used biomarkers in clinical laboratory practice for diagnosing acute-phase inflammation, even at stages where leukocyte counts are within the reference range and leukocytosis is not yet evident. According to F. Blaga *et al.* (2024), CRP concentrations in blood increase sharply within 46 hours after exposure to an inflammatory stimulus and reach peak levels in approximately 24-48 hours. However, CRP is highly sensitive and has significant diagnostic value in cases of subclinical disease. In cases of lameness, CRP assessment can facilitate differential diagnosis between immunemediated or septic arthritis and other conditions that do not cause changes in CRP, such as intervertebral disc protrusions and secondary paraplegia due to acute intervertebral disc extrusion.

E. Gori *et al.* (2023) noted that erythrocytes settle more rapidly in the plasma of patients with acute inflammation, leading to an increased ESR. Consequently, ESR is traditionally used as an additional marker alongside acute-phase proteins. Due to its lack of specificity, ESR is typically included in a general inflammatory index, along with patient history, physical examination, and clinical pathology results, as reported by C. Pye *et al.* (2022). ESR determination is a simple laboratory diagnostic method primarily used to detect infectious and inflammatory processes in the body. The main reason for changes in ESR is alterations in plasma properties, particularly the protein composition, resulting from elevated temperature, allergic and inflammatory reactions, increased malignant cells, and the presence of foreign microorganisms. Various proteins and specific antibodies produced in response to the body's defence mechanisms reduce the negative charge of erythrocytes, weakening their ability to repel each other. As a result, red blood cells begin to actively settle at the bottom of a vertical tube. This occurs in cases of infectious diseases, autoimmune diseases, neoplasms, inflammatory processes, purulent diseases, necrosis, and certain chronic conditions.

A. Hillström *et al.* (2016) highlighted that CRP is an acute-phase protein synthesised in hepatocytes in response to increased interleukin-6 (IL-6) levels during inflammation. The measurement of plasma CRP concentrations in dogs has been established as a reliable clinical test for the diagnosis and monitoring of systemic inflammatory diseases. A key advantage of CRP in clinical research is its ability to reflect the intensity and extent of the inflammatory process, and importantly, it is unaffected by the use of nonsteroidal anti-inflammatory drugs or glucocorticoids. This distinguishes CRP from other markers of systemic inflammation, such as fever and leukogram analysis.

This study demonstrated that there was no breed predisposition to the disease in question. The results obtained align with the findings of other researchers. For instance, V. Klymchuk (2019) found that dogs of various breeds were susceptible to developing this pathology due to poor breeding practices and the inclusion of dogs with signs of gonarthrosis in breeding programs. K. Anderson *et al.* (2020) discovered that certain breeds have a particular predisposition and risk for developing joint diseases due to both conformations, related to breed standards, and genetic or hereditary components that increase the likelihood, but do not guarantee, the development of joint disease in individuals of that breed.

N. Budhiparama *et al.* (2024) and M. Enomoto *et al.* (2024) reported that orthopaedic examinations of animals often reveal various manifestations of pain during joint manipulation, as well as limited range of motion and joint swelling. The superiority of radiographic diagnosis over clinical examination has also been demonstrated (radiographic changes are diagnostically effective in 90% of animals, compared to only 50% showing clinically evident osteoarthritis on clinical examination alone). M. Enomoto *et al.* (2024) further established that radiographs of osteoarthritic joints typically reveal osteophytes, bony growths around the joint associated with cartilage destruction, and mineralised enthesophytes at the sites where ligaments attach to bone. The radiographic examination allows for the diagnosis of the following pathological conditions in the joint: effusions indicating the presence of fluid or swelling in the joint (soft tissue swelling) or bone cysts. Visualisation of subchondral sclerosis indicates increased mineralisation of the bone around the joint, usually due to joint overload.

N. Budhiparama *et al.* (2024) found that X-rays are commonly used to visualise bones and joints. X-rays can reveal changes in the joint space, the presence of bone spurs, and other degenerative changes. While X-rays are useful, they may not detect early-stage osteoarthritis. Magnetic resonance imaging can provide more detailed images of soft tissues, such as cartilage and ligaments. It is more sensitive in detecting early changes within the joint. Computed tomography can provide detailed images of bones and is sometimes used to assess joint damage, particularly in weight-bearing joints. Modifying the lifestyle of an affected animal can help alleviate their overall condition. This involves maintaining the animal's weight within physiological parameters and taking them for walks on a leash.

A. Cohen (2024) found that dogs with musculoskeletal disorders are often prescribed supplements such as glucosamine and chondroitin sulphate, as well as omega-3 fatty acids. Surgical interventions may be recommended for conditions like hip dysplasia or cruciate ligament rupture. Today, a wide range of medications is used to treat canine osteoarthritis. For example, nonsteroidal anti-inflammatory drugs are commonly prescribed to reduce pain and inflammation in animals with joint conditions of various aetiologies. P. Adams *et al.* (2011) found that gabapentin and amantadine are often prescribed as adjunctive medications in conjunction with NSAIDs. Another modern treatment for osteoarthritis is Librela (bedinvetmab), a type of injectable medication known as a monoclonal antibody that can be administered once a month for long-term pain control in osteoarthritis. It targets a specific pain factor in this disease called nerve growth factor (NGF). However, as B. Dobenecker *et al.* (2024) argued, this method may not be economically viable for some pet owners.

M. Langworthy *et al.* (2024) found that the initial results of evaluating the effectiveness of anti-NGF monoclonal antibodies are promising as an alternative therapy for dogs with joint pathology. M. Berninger *et al.* (2013) established that the use of autologous platelet-rich plasma, stem cells, and monoclonal antibodies can facilitate a positive resolution of orthopaedic challenges in treating musculoskeletal diseases. D. Primorac *et al.* (2020) noted that PRP is derived from blood and contains plasma with a higher concentration of platelets than peripheral blood. P. Allen *et al.* (2019) discovered that blood plasma can also contain varying amounts of leukocytes. C. Pye *et al.* (2022) demonstrated that platelets are an integral part of blood clotting and release growth factors such as platelet-derived growth factor, transforming growth factor beta, epidermal growth factor, and vascular endothelial growth factors. These growth factors stimulate processes such as angiogenesis and chondrocyte proliferation while reducing chondrocyte apoptosis. Thus, the results of clinical and instrumental studies on dogs with knee osteoarthritis, before and after treatment with autologous platelet-rich plasma administered intra-articularly, confirm the effectiveness of the proposed cell therapy method.

Conclusions

The presented study provides results on the prevalence of various musculoskeletal pathologies in dogs. Osteoarthritis was recorded in 52% of the examined dogs; cruciate ligament rupture was diagnosed in 43%; varying degrees of knee joint contusion were found in 1.2% of individuals; and joint dislocation, as well as foreign bodies such as osteophytes and joint mice, were found in 0.6% and 2% of cases, respectively. Evaluating the overall condition of the animals, it was found that degenerative-dystrophic disease of the knee joint, caused by pathological destruction of the articular cartilage, was accompanied by the development of pain syndrome in all dogs. This syndrome was observed in affected animals both at rest and during passive movements of the affected limb, as well as upon palpation of the periarticular tissues. The study of the dynamics of the pain syndrome allowed for an assessment of the effectiveness of treating dogs with osteoarthritis using autologous platelet-rich plasma via intra-articular injection. Radiographic examination of the knee joint before and after a course of cell therapy in diseased dogs revealed the absence of further degenerative changes in the intra-articular tissues and a slight increase in the joint space, indicating a positive dynamic with the use of the aforementioned plasma. On the 7th day after completing the course of intra-articular injections of autologous platelet-rich plasma, the study dogs showed no lameness and had improved overall clinical condition with increased locomotor activity. Blood analysis revealed a significant decrease in erythrocyte sedimentation rate by 42.6% ($P < 0.001$) and C-reactive protein levels by 15.6% ($P < 0.001$). On the 90th day after the completion of the treatment course, there was a further significant decrease in erythrocyte sedimentation rate by 71.3% ($P < 0.001$) and C-reactive protein by 93.5% ($P < 0.001$), indicating a reduction in systemic inflammation. These results demonstrate the high efficacy of intra-articular platelet-rich plasma therapy for the treatment of canine osteoarthritis, as supported by both laboratory and imaging data. Future research plans to investigate the application of autologous platelet-rich plasma in the treatment of joint pathologies in cats and exotic animals.

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Conflict of Interest

None.

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Лікування собак за остеоартрозу з використанням аутологічної плазми крові, збагаченої тромбоцитами

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Анотація. Актуальність дослідження зумовлена стрімким зростанням випадків захворювання собак на остеоартроз колінного суглобу. Клінічно ця патологія проявляється розвитком кульгавості різного ступеня, що істотно погіршує якість життя цих тварин. У зв'язку з цим, мета роботи полягала у визначенні особливостей змін показників гострої фази запалення в крові собак за остеоартрозу колінного суглобу на тлі внутрішньосуглобового введення аутологічної плазми крові, збагаченої тромбоцитами. Діагностичним підходом у роботі було визначення в крові вмісту гострофазного С-реактивного білка та величини швидкості осідання еритроцитів. Зміни у тканинах хворого суглобу досліджували з використанням методу рентгенологічного дослідження, на першу добу застосування плазми і на 90 добу після курсу лікування, з метою оцінки динаміки репаративних процесів у колінному суглобі.

Таким чином, встановлено, що на 14 добу після останнього внутрішньосуглобового введення аутологічної плазми, збагаченої тромбоцитами, рівень С-реактивного білка і величина швидкості осідання еритроцитів у крові мали чітку тенденцію до зниження відповідно до показників референтних значень. На 21 добу відмічали відновлення параметрів зазначених маркерних показників у крові в двох із п'яти собак, що відповідали фізіологічним межам, а у трьох інших досліджуваних тварин показники продовжували знижуватися. Вже на 90 добу після проведеного курсу внутрішньосуглобових ін'єкцій всі показники в п'яти собак набували фізіологічних значень. Результати рентгенологічного дослідження до і після проведеного курсу клітинної терапії вказували на відсутність подальших дегенеративних змін та незначне збільшення суглобової щілини, що доводить ефективність використання аутологічної плазми, збагаченої тромбоцитами, за коксартрозу в собак. Отримані результати мають важливе прикладне значення як для науковців, так і для практикуючих ветеринарних лікарів, що сприятиме удосконаленню протоколу лікування тварин за остеоартрозу колінного суглобу

Ключові слова: гонартроз; маркери запалення; С-реактивний білок; швидкість осідання еритроцитів; рентгенографія; клітинна терапія