Diagnosis and Treatment of Degenerative Joint Disease in a Captive Male Chimpanzee (*Pan troglodytes*)

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Degenerative joint disease (DJD), also known as osteoarthritis, has been well documented in aging populations of captive and free-ranging macaques; however, successful treatments for DJD in nonhuman primates have not been published. Published data on chimpanzees show little to no DJD present in the wild, and there are no published reports of DJD in captive chimpanzees. We report here the first documented case of DJD of both the right and left femorotibial joints in a captive male chimpanzee. Progression from minimal to moderate to severe osteoarthritis occurred in this animal over the course of 1 y. Treatment with chondroprotective supplements (that is, glucosamine chondroitin, polysulfated glycosaminoglycan) and intraarticular corticosteroid injections (that is, methylprednisolone, ketorolac), together with pain management (that is, celecoxib, tramadol, carprofen), resulted in increased activity levels and decreased clinical signs of disease. DJD has a considerable negative effect on quality of life among the human geriatric population and therefore is likely to be one of the most significant diseases that will affect the increasingly aged captive chimpanzee population. As this case study demonstrates, appropriate treatment can improve and extend quality of life dramatically in these animals. However, in cases of severe osteoarthritis cases, medication alone may be insufficient to increase stability, and surgical options should be explored.

Abbreviation: DJD, degenerative joint disease.

Degenerative joint disease (DJD) or osteoarthritis is the most common joint disorder seen in humans, affecting some 60% to 70% of adults 60 y of age and older.[1,27] Among nonhuman primates, DJD has been documented in both captive[3-6,9,18,26] and free-ranging[21,29] macaque populations, with the disease affecting as much as 55% to 79% of the aged (older than 15 y) population.[3-5,9,21] In addition, osteoarthritis has been reported among captive New World monkeys[33,35] and prosimians.[32,35] However, existing data for great apes show little to no DJD present in the wild.[14,22,24,30,31] In addition, there are no published reports of DJD in captive chimpanzee populations; however, the few published reports of captive gorillas suggest that DJD may be more prevalent than previously reported.[25,39]

Osteoarthritis is a complex and progressive disease resulting in damage to and loss of articular cartilage, attrition of subarticular bone, diminished joint space, formation of osteophytes, and often synovial distension and inflammation.[1] Among men and women, DJD occurs most frequently in the hands (50% to 70% of cases),[15,19,36] followed by knee joints (25% to 40%),[15,36] hip joint (10% to 20%),[15,19,36] and upper back and shoulders (5% to 10%).[15,19,36] Among free-ranging[21,29] and captive[3-6] macaques, DJD occurs in the hands (55% of cases),[19] lumbar spine (69% to 78%),[5,6,9] and knee and hip joints (32% to 67%).[4,29] In addition to the similarity in prevalence rates, osteoarthritis increases with age and obesity in both humans[1,27] and macaques[4,23] and is radiologically and histologically similar.

The increasing numbers of geriatric (older than 30 y) chimpanzees in captivity likely will generate new challenges for veterinary care and captive management. Given that DJD is one of the leading causes of disability in aged Americans (older than 60 y) and has considerable influence on quality of life,[1,19] the increasingly aged chimpanzee population likely will also be affected by the disease. We report here the diagnosis and treatment of severe osteoarthritis (DJD) in a chimpanzee (*Pan troglodytes*).

Case Study

Each animal at our facility (Alamogordo Primate Facility, Holloman Air Force Base, NM) annually receives a complete physical examination under sedation with tiletamine hydrochloride–zolazepam (3.5 mg/kg; Telazol, Fort Dodge Animal Health, Fort Dodge, IA), CBC, clinical chemistry, electrocardiography, abdominal ultrasonography, tuberculosis testing, dental prophylaxis, and blood pressure assessment. Chimpanzees are housed socially and maintained in accordance with the *Guide for the Care and Use of Animals*.[13] All procedures were approved by an institutional animal care and use committee. The facility and its program are fully AAALAC-accredited. No research occurs at the facility. Pain and locomotion of all animals are assessed by veterinary and animal care staff on a regular basis by using a pain score scale (Figure 1).

In June 2006, animal care staff at our facility noted that a 25-y-old ,95-kg, captive-born, socially housed male chimpanzee (negative for hepatitis B virus, hepatitis C virus, and HIV1) was slow-moving and slightly lame on his left leg during morning observation sessions. However during the afternoon, the animal would appear to have no lameness, pain, or discomfort and was active. During physical examination, the left femorotibial joint had decreased range of motion and a considerable amount of crepitus. The knee area had minimal swelling, with no joint effusion noted. Radiographs revealed marginal osteophyte formation at the joint capsule attachment and a slight nar-

Score	Pain level	Appearance or behavior
0	None	Normal movement, appearance, appetite, interactions, and behavior. Heart and respiratory rates are within normal range.
1	Mild	Normal interactions and appetite. Slight reluctance to use limbs or digits. Heart and respiratory rates within normal range.
2	Mild–moderate	Slight decrease in interactions and appetite. Slight increase in heart and respiratory rates. Decreased movements.
3	Moderate	Mild to moderate decrease in interactions and appetite. Slight increase in heart and respiratory rates. Very reluctant to move, but will move if coaxed.
4	Moderate–severe	Moderate to severe decrease in interactions and appetite. Increase in heart and respiratory rates. Very reluctant to move; may not move even if coaxed.
5	Severe	No interactions observed, and inappetance is seen. Heart and respiratory rates are increased 50% or more. Body position is in recumbancy. Very reluctant to move, even if coaxed.

Analgesics are recommended for pain scores of 1 through 5.

Figure 1. Pain assessment scores.

Grade	Level of osteoarthritis	Features
0	None	None
1	Doubtful	Minute osteophytes; doubtful significance
2	Minimal	Definite osteophytes; unimpaired joint space
3	Moderate	Definite osteophytes; moderate diminution of joint space
4	Severe	Definite osteophytes; joint space greatly impaired with sclerosis of subchondral bone

From reference 1.

Figure 2. Kellgren–Lawrence system of grading osteoarthritis.

rowing of the joint space, resulting in a diagnosis of minimal to moderate osteoarthritis (that is, grade 2 to 3 according to the Kellgren–Lawrence Grading System, Figure 2).[1] The right femorotibial joint appeared normal. The chimpanzee was placed on a course of celecoxib (200 mg daily for 30 d; Celebrex, Pfizer, New York, NY). The lameness resolved, and the animal did not exhibit any further clinical signs until June 2007.

Prior to the animal's annual physical examination in June 2007, animal care staff noted minimal lameness in the chimpanzee's right leg and assigned a pain score of 2 (Figure 1). During examination, mild swelling was noted on the medial aspect of the right femorotibial joint. An orthopedic evaluation was performed, with both cranial drawer and tibial compression tests being negative. Radiographs of the left femorotibial joint (Figure 3 A) showed an increase in marginal osteophyte formation at the joint capsule attachment, periarticular remodeling, and a continued narrowing of the joint space, resulting in a diagnosis of moderate osteoarthritis (grade 3 on the Kellgren–Lawrence Grading System, Figure 2).[1] Radiographs showed no osteal changes to the right femorotibial joint (Figure 3 B), resulting in a diagnosis of minimal osteoarthritis (grade 1 on the Kellgren–Lawrence Grading System).[1] The animal was given ketoprofen (180 mg IM; Ketofen, Fort Dodge Animal Health) and was prescribed carprofen (75 mg twice daily; Rimadyl, Pfizer). The chimpanzee was placed on cage rest for 5 d and was returned to his den after increased use of the right leg was noted.

An increase in mobility was observed over the next 45 d; however, mild lameness continued and alternated between the left and right legs (pain score 1, Figure 1). During a follow–up examination in August 2007, radiographs showed osteophytes and periarticular bone proliferation on the right femur and tibia (Figure 4). In addition, the right femorotibial joint showed 40% decreased range of motion and mild crepitus; however, little joint laxity was demonstrated with the anterior drawer technique. These findings resulted in a diagnosis of minimal to moderate osteoarthritis (Kellgren–Lawrence grade 2 to 3, Figure 2).[1] Radiographs and range-of-motion tests showed no change in the left femorotibial joint. A regimen of glucosamine chondroitin (1500 mg daily; Solgar, Leonia, NJ) and tramadol (50 mg twice daily, Amneal Pharmaceuticals, Glasgow, KY) was initiated; carprofen (75 mg twice daily) was continued. Polysulfated glycosaminoglycan (350 mg IM; Adequan Novartis, Larchwood, IA) was administered every 14 d for 2 mo.

In October 2007, a follow-up physical examination was performed to reassess the chimpanzee's health status and progress of DJD. Radiographs showed no new osteophytes or periarticular bone proliferation of either the right or left femur or tibia. Range of motion in both joints was unchanged, lameness was noted in both legs, and the pain score had increased to level 2 (Figure 1). In addition, the anterior drawer technique revealed considerable laxity of the right femorotibial joint. A tear in the anterior cruciate ligament was suspected to have occurred secondary to osteoarthritis.

In October 2007, after consultation of veterinary staff with a board-certified orthopedic surgeon, the chimpanzee began intraarticular injections of ketorolac tromethamine (20 mg; Toradol, Roche, Nutley, NJ) and methylprednisolone sodium succinate (40 mg; SoluMedrol, Pfizer). Injections were administered by using the medial approach to the femorotibial joint. Alternate femorotibial joints were injected every 2 wk for 8 wk, resulting in 2 injections per joint. The regimen of glucosamine chondroitin, tramadol, and carprofen was continued.

The intraarticular injections were continued for 3 mo, with serial radiographs and evaluations every 1 to 2 mo. The chimpanzee
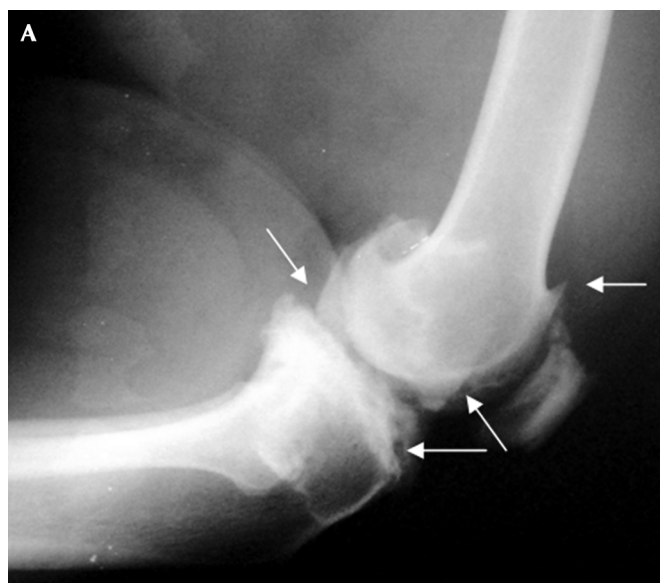
Figure 3. Radiographs of the (A) left and (B) right femorotibial joints in June 2007. Arrows indicate formation of osteophytes, narrowing of joint space, and presence of periarticular remodeling of the left femorotibial joint.
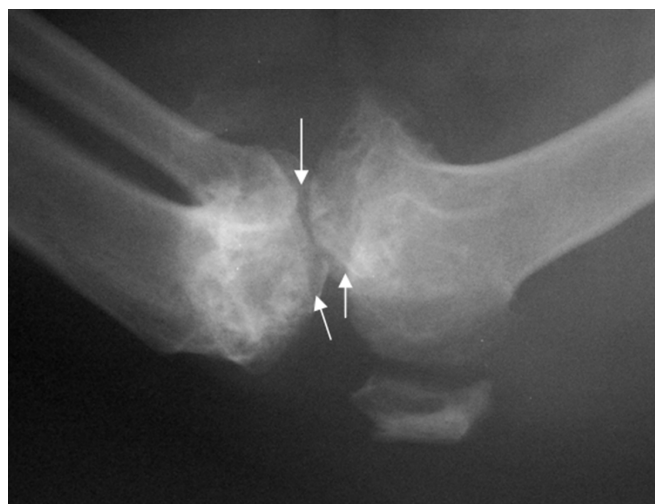

Figure 4. Radiographs of the right femorotibial joint in August 2007. Arrows indicate formation of osteophytes, narrowing of joint space, and presence of periarticular remodeling.

has shown a modest decrease in clinical signs, and his comfort level has improved, as have his activity level and interaction with denmates. His pain score has decreased from 2 to level 0 to 1, and the animal has been observed to use both limbs, although he still tends to favor the right leg. Surgical options have been explored in an effort to further stabilize the joint and slow the progression of the disease.

Discussion

Degenerative joint disease is a progressive deterioration of the articular cartilage with various degrees of periarticular remodeling.[1] Synovitis usually occurs first and results in progressive degradation of the joint cartilage, sometimes leading to degeneration of the anterior cruciate ligament and subsequent instability of the joint.[7,17] DJD is common among aged humans[1] and aging populations of captive and free-ranging macaques.[5,6,29] However, the disease has rarely been reported for great ape species and is believed to be absent among wild chimpanzees.[14,22,24] This difference is likely due to variations in life expectancies and body weights between wild and captive

populations, given that both increased age and obesity are significant risk factors for DJD in humans.[1] Captive chimpanzees are more likely to reach old age than are their wild counterparts, in that by the age of 15 y, captive chimpanzees have a life expectancy of 45 y,[10] compared with a life expectancy of 30 y for wild chimpanzees.[12] In addition, captive chimpanzees (females, 52 to 55 kg; males, 58 to 63 kg)[38] tend to weigh significantly more than their wild counterparts (females, 31 to 41 kg; males, 39 to 47 kg).[28] Therefore, as they age, captive chimpanzees may show increased clinical signs of DJD, as compared with their wild counterparts, due to the increased weight of captive chimpanzees and the effect of hard floor surfaces on joint stress.[20] Increased attention and screening for DJD among captive chimpanzees, as well as the development of alternative treatment plans, will likely be required.

Successful treatment of DJD requires not only pain management but also should attempt to slow down or halt progression of the disease.[16] Initial treatments for DJD in humans generally address pain management through the use of either nonsteroidal antiinflamatory drugs or selective cyclooxygenase 2 inhibitors (that is, celecoxib) as well as chondroprotective supplements, such as glucosamine and chondroitin sulfates.[2] The use of glucosamine and chondroitin sulfates remains controversial, and results of their effectiveness in pain management and reversing joint degeneration have been mixed.[2,16,37] Treatments for moderate to severe DJD often include opioids (that is, tramadol, txycodone) and intraarticular injections of either corticosteroids (that is, triamcinolone, methylprednisolone) or hyaluronic acid.[2,11] Corticosteroid and hyaluronic acid injections both can result in pronounced pain relief, but hyaluronic acids tend to have a slower onset of efficacy and a longer effect.[9] Disadvantages of hyaluronic acid include the need for a series of weekly injections (typically 5 or more) and its cost prohibitiveness.[11,17]

DJD of the human knee typically progresses slowly, taking several years to progress from mild to severe.[1] In contrast, the disease progressed much more quickly in this chimpanzee case study, taking only 1 y to progress from mild to severe DJD in both knees. Previous studies of ground force during locomotion and articular joint surfaces have demonstrated that chimpanzee locomotion results in much greater joint stress than does human bipedalism.[8,20,34] This high level of joint stress, coupled with habitual locomotion on hard surfaces, likely makes captive

chimpanzees more prone to DJD than their wild counterparts. Successful treatment of DJD in captive chimpanzees can be problematic because of the high frequency of dosing (as for hyaluronic acid) and the high activity level of group-housed chimpanzees. However, in light of the appropriate levels of pain management and inclusion of intraarticular injection therapy, the current case study demonstrates that we can extend the quality of life for captive chimpanzees as they progress into old age.

Acknowledgments

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