Tieteellinen artikkeli

Aija Mehtälä, Katariina Thomson and Pauli Keränen

Koiran polvinivelen bakteeritulehdus, hoito tähystysavusteisin nivelhuuhteluin yhdistettynä antibioottihoitoon ja implanttien poistoon – tapausselostus

Case report of septic arthritis of the stifle joint in a White German Shepherd dog – treatment with repeated arthroscopic lavage, antimicrobial therapy and implant removal

YHTEENVETO

Potilaamme oli 41,5-kiloinen kuusivuotias kastroitu valkoinenpaimenkoirauros. Koira alkoi äkillisesti ontua vasenta takajalkaansa. Yliopistolliseen eläinsairaalaan tuotaessa se oli hyvin väsynyt. Koiran vasen polvi oli leikattu 2,5 vuotta aiemmin etummaisen ristisiteen vamman vuoksi TTA-tekniikalla (tibial tuberosity advancement) ja puoli vuotta TTA-leikkauksen jälkeen lateraalisutuurimenetelmällä. Lisäksi koira oli saanut useita nivelensisäisiä injektioita. Koiran historian, kliinisen yleistutkimuksen, nivelnestenäytteen sytologian ja viljelyn perusteella totesimme äkillisen ontuman syyksi vasemman polvinivelen bakteriellin niveltulehduksen. Hoitovaihtoehdot ovat kirurginen, lääkinnällinen tai niiden yhdistelmä. Kirurginen hoito tarkoittaa nivelhuuhtelua joko tähystämällä tai arthrotomialla ja tarvittaessa myös implanttien poistoa, kun taas konservatiivihoito tarkoittaa paikallista ja/ tai systeemistä antibioottilääkitystä. Lievää bakteriellia niveltulehdusta voidaan hoitaa neulojen läpi tehtävällä huuhtelulla sekä systeemisellä antibioottikuurilla, mutta vakavammissa tapauksissa tähystysavusteinen nivelhuuhtelu on suositellumpaa. Tähystysavusteinen huuhtelu poistaa tehokkaammin fibriiniä ja muita tulehduspartikkeleita nivelestä sekä sallii samalla nivelen tutkimisen visuaalisesti. Tapauksen niveltulehdus hoidettiin menestyksellisesti toistetuilla tähystysavusteisilla nivelhuuhteluilla, antibiooteilla ja implanttien poistolla. Huuhtelun ja antibioottihoidon kombinaatio voi estää nivelrikon etenemistä parantamalla tulehduksen ja normalisoimalla raajan käytön mahdollisimman nopeasti, kuten tämä potilastapaus osoitti.

SUMMARY

A 6-year-old, castrated male White German Shepherd dog weighing 41.5 kg was presented with lethargy and acute lameness of the left hind limb. The dog had a history of cruciate ligament rupture of the left stifle joint and had undergone several surgical and medical interventions. Tibial tuberosity advancement (TTA) surgery and a lateral suture operation on the left stifle had been performed 2.5 years and 2 years ago, respectively. On presentation at the Veterinary Teaching Hospital the dog was diagnosed with septic arthritis of the stifle joint based on the history, clinical signs, joint fluid cytology and bacteriologic culture. Surgical management of septic arthritis includes joint lavage, arthroscopic inspection or arthrotomy and possibly implant removal, whereas medical management includes local and/ or systemic antibiotic therapy. A mild septic arthritis can be treated by large-bore needle irrigation and antibiotics but in more severe cases, arthroscopic lavage is recommended. Arthroscopic lavage removes more effectively fibrin and infectious material from the septic joint and allows good visual evaluation of the joint. The infection of this case was successfully treated with repeated arthroscopic lavage, antimicrobial therapy and removal of the implants. Lavage combined with intravenous antibiotics can preserve the joint from arthritic degeneration and provide complete healing of the infection and good restoration of limb function with minimized cartilage damage as in this case.

INTRODUCTION

Septic arthritis (bacterial arthritis, infective arthritis, suppurative arthritis) is a joint infection caused by bacteria or other microorganisms. While canine septic arthritis is rare, it should be suspected if a patient presents with severe pain and the joint is swollen and hot.[1] The dog is lame and usually shows systemic signs of clinical illness. Similar signs can also be seen in other types of arthritis such as immune-mediated arthropaties.[1] However, in these cases several joints are usually affected and no bacteria are seen in joint fluid cytology.

Infection can disseminate to a joint from adjacent soft tissue or osteomyelitis.[2-5] Reports on the pathogenesis of bacterial infective arthritis in adult dogs suggest that a penetrating wound, including surgery, is the most common cause.[2,3] Open-joint surgery is a bigger risk for septic arthritis than arthroscopy. About 1% canine patients undergoing arthroscopy develop septic arthritis.[3,6] The most common reason for septic arthritis in puppies is haematogenous spread. In cases of infective arthritis of hematogenous origin, several joints can be affected.[3] Adult dogs can also be susceptible to the haematogenous spread of bacteria into the joint if the dog has an underlying immunosuppression, corticosteroid therapy or diabetes mellitus.[2] Osteoarthritis may also predispose to bacterial infective arthritis as well as an active infection in other organs, such as cystitis or periodontal disease.[7]

Infective arthritis is most commonly seen in the stifle, elbow and carpus.[2-4] The diagnosis of bacterial infective arthritis is based on three criteria. First, a typical history and clinical signs such as severe lameness and joint effusion with or without pyrexia, anorexia and depression are seen. These signs can be acute or chronic.[1,3,4] In addition, radiographs show a soft tissue reaction and joint effusion in an early stage of septic arthritis, and later osteoarthritic changes become more evident.[4]

Secondly, the cytological features of the synovial fluid are consistent with bacterial infective arthritis.[3] The number of polymorphonuclear cells (neutrophils) is increased. This makes the synovial fluid turbid, alter the color and reduces fluid viscosity. Normal synovial fluid usually contains less than 3 x 10^9/ l cells, whereas in a septic joint, the cell count is 15–267 x 10^9/ l, and may even be higher. Cytological analysis may reveal an increased number of neutrophils that may have phagocytized bacteria. Normally in the synovial fluid sample the proportion of neutrophils and mononuclear cells is less than 10% neutrophils and more than 90% mononuclear cells, whereas in an infectious fluid the proportion of neutrophils is greater than 90%.[8] Moreover, the total protein concentration is high in septic joint fluid, being over 25 g/ l.[8]

Thirdly, the diagnosis of septic arthritis is confirmed by a positive bacteriological culture. The most common bacteria isolated from septic joints are staphylococci and beta-haemolytic streptococci.[2,4,9] However, positive bacterial cultures are obtained in approximately 50% of the cases.[8] Even in cases where bacterial fluid has been inoculated into the joint space, later bacterial culture may be negative.[10] One reason is thought to be the inactivation of bacteria by high enzyme activity in the joint fluid. Other possible reasons include previous antimicrobial treatment, infection caused by non-culturable bacteria or bacteria requiring a special culture environment for growth. Treatment is indicated even if bacteria cannot be cultured, if history, clinical signs and cytological findings are consistent with septic arthritis,.[3]

Untreated septic arthritis can destroy the joint cartilage and synovial membrane, leading to osteoarthritic changes.[11] There is no consensus on the treatment protocol for septic arthritis in human or canine medicine. Surgical management includes joint lavage, arthroscopic inspection or arthrotomy and possibly implant removal, whereas medical management includes local and/ or systemic antibiotic therapy.[1] In equine patients, arthroscopic intervention has been shown to be superior to other treatment options.[12] In one canine study, arthroscopic lavage effectively improved the outcome in the dog.[5]

MAIN POINTS

- Septic arthritis is destructive to joint cartilage and synovial membrane.
- It can result from a traumatic penetrating wound, hematogenous spread or iatrogenic origin.
- Criteria for bacterial infective arthritis are typical history and clinical signs and synovial fluid cytology consistent with infective arthritis. A positive bacteriologic culture confirms the diagnosis.
- Treatment of septic arthritis, which can be surgical or medical or a combination of those, should be initiated without delay.
- The duration of the treatment depends on the respond of the patient and the laboratory values.

Artikkeli tuli toimitukseen 26.3.2018.

CASE

A 6-year-old castrated male White German Shepherd dog weighing 41.5 kg was presented for the first time to the Veterinary Teaching Hospital of the University of Helsinki due to lethargy and acute lameness of the left hind limb.

The owner reported the following history: The dog had undergone tibial tuberosity advancement (TTA) surgery on the left stifle 2.5 years earlier due to cranial cruciate ligament rupture. Three weeks after the surgery, soft tissue swelling around the stifle joint and dehiscence of the incision was noted. There was no obvious effusion of the joint and the microbiological culture of the joint fluid was negative. Ten months later, the dog was presented to another veterinarian because of lameness of the left hind limb. The lameness had persisted for 3 weeks. The left stifle joint was painful and unstable in orthopaedic examination. In an ultrasound examination, damage to the medial meniscus was seen. After this visit, the dog received several intra-articular medications, including local anaesthetics, antimicrobials, sodium hyaluronate and interleukin-1 receptor antagonist protein therapy (IRAP). Later, due to the persistent instability of the stifle joint, an attempt to stabilize the joint was performed surgically with two lateral sutures using nylon leaders and metallic clamps.

At clinical presentation at the Veterinary Teaching Hospital, the dog was depressed and had a temperature of 39.9 °C. The lameness score of the left hind limb was 3 (scale 0–4). The left stifle joint was swollen and painful on palpation.

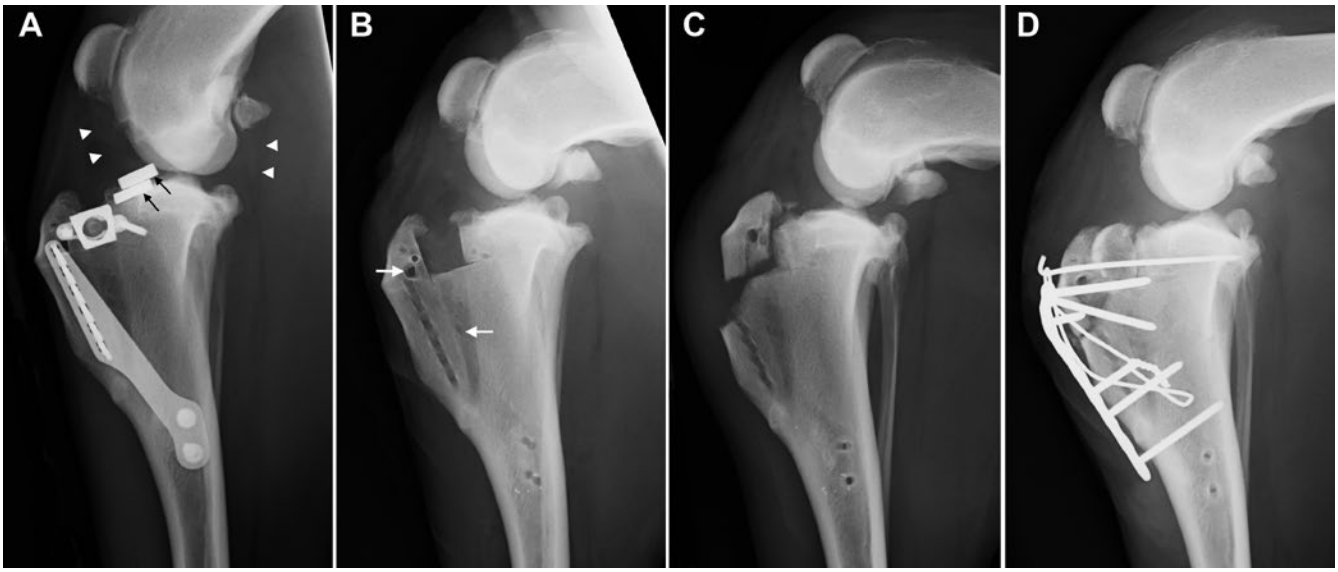

FIGURE 1 KUVA

A) A radiograph of the left stifle joint taken on day 0. Joint effusion (paired white arrowheads on both sides of the knee joint indicating the joint capsule margins) and osteophytes on joint margins are seen. The cruciate ligament surgeries had previously been performed elsewhere. Black arrows point to the crimp tubes used to fix the extracapsular lateral sutures. Distally, the TTA cage and plate are seen. B) A radiograph after implant removal on day 8. Left arrow points to the osteolytic hole in the tibial tuberosity originally drilled for lateral sutures. Right arrow indicates an osteolytic area in the proximal tibia. C) Day 18, the tibial tuberosity fractured due to the lack of support after implant removal. The infection was under control. D) The fracture of the tibial tuberosity was repaired using a bone block harvested from the ipsilateral iliac crest. The bone block and tibial tuberosity were stabilized with a Kirchner wire and a tension band wire. The fixation was additionally supported by a cranially placed 2.0 mm LCP fixed with locking screws.

A) Vasemman polven septisen artriitin röntgenkuva diagnoosipäivänä (päivä 0): polvinivelessä täyttymistä (parilliset nuolenpäät nivelen molemmin puolin rajaavat täyttyneen nivelkapselin) ja nivelpinnan reuna-alueiden luupiikkejä. Etummaisen ristisiteen korjausleikkaukset oli tehty muualla aiemmin. Mustat nuolet osoittavat lateraalisutuuroiden kiinnittimiä. Sääriluun yläpäässä näkyvät TTA-leikkauksessa asennettu TTA-häkki ja -levy. B) Röntgenkuva implanttien poiston jälkeen (päivä 8). Vasen nuoli osoittaa sääriluun kyhmyn alueella lateraalisuturan kiinnitysreikää, jossa on luukatoa. Oikeanpuoleinen nuoli osoittaa luukatoaluetta sääriluun yläpäässä. C) Sääriluun kyhmy murtui implantin poiston jälkeen (päivä 18). Polvinivelen infektio oli silloin jo parantunut. D) Sääriluun kyhmyn defekti täytettiin vasemmasta suoliluusta otetulla luusiirteellä. Luusiirre ja sääriluun kyhmy kiinnitettiin paikoilleen Kirschner-piikillä ja jännitesidoksella sekä 2.0 mm lukkolevyllä.

Craniocaudal and lateral radiographs of the left stifle joint showed joint effusion and osteoarthritic changes (figure 1A) and osteolysis of the proximal tibia (figures 1A and 1B).

The blood biochemistry profile and a complete blood count revealed mild leukocytosis (17.7 x 10^9/ l, reference range 5.4–17.4). The joint fluid was collected into an EDTA tube for cytological assessment and into a sterile plain tube for bacterial culture, which was performed immediately. The joint fluid in the left stifle was cloudy and the total nucleated cell count was 58.3 x 10^9/ l, with 95.5% neutrophils and 4.5% mononuclear cells. The total protein concentration was 48 g/ l. Treatment was initiated with meloxicam 0.1 mg/ kg once a day, gabapentin 10 mg/ kg twice a day and cephalexin 30 mg/ kg three times a day.

The diagnosis of septic arthritis was confirmed by a pure culture of *Staphylococcus aureus* isolated from the synovial fluid. The bacterium was susceptible to oxacillin, amoxicillin-clavulanic acid, cephalothin, erythromycin, clindamycin, trimethoprim-sulfamethoxazole, tetracycline, fucidic acid, doxycycline, enrofloxacin and gentamicin, but resistant to penicillin G.

The stifle joint was arthroscopically lavaged to remove infectious material. The procedure was performed under general anaesthesia combined with nerve blocks. The antibiotics used were cefazolin 22 mg/ kg and enrofloxacin 10 mg/ kg. Postoperative pain medication consisted of meloxicam 0.1 mg/ kg once a day and tramadol 2 mg/kg three times a day.

Routine stifle joint arthroscopic portals were utilized (figure 2). The joint was irrigated with 5000 ml of 0.9% sterile saline using a pressure bag (80 mm Hg).

The dog was hospitalized over the weekend and received intravenous fluids, intravenous antibiotics including cefazolin 22 mg/ kg three times a day and enrofloxacin 7.5 mg/ kg twice a day, meloxicam and tramadol as well as oral gabapentin. On

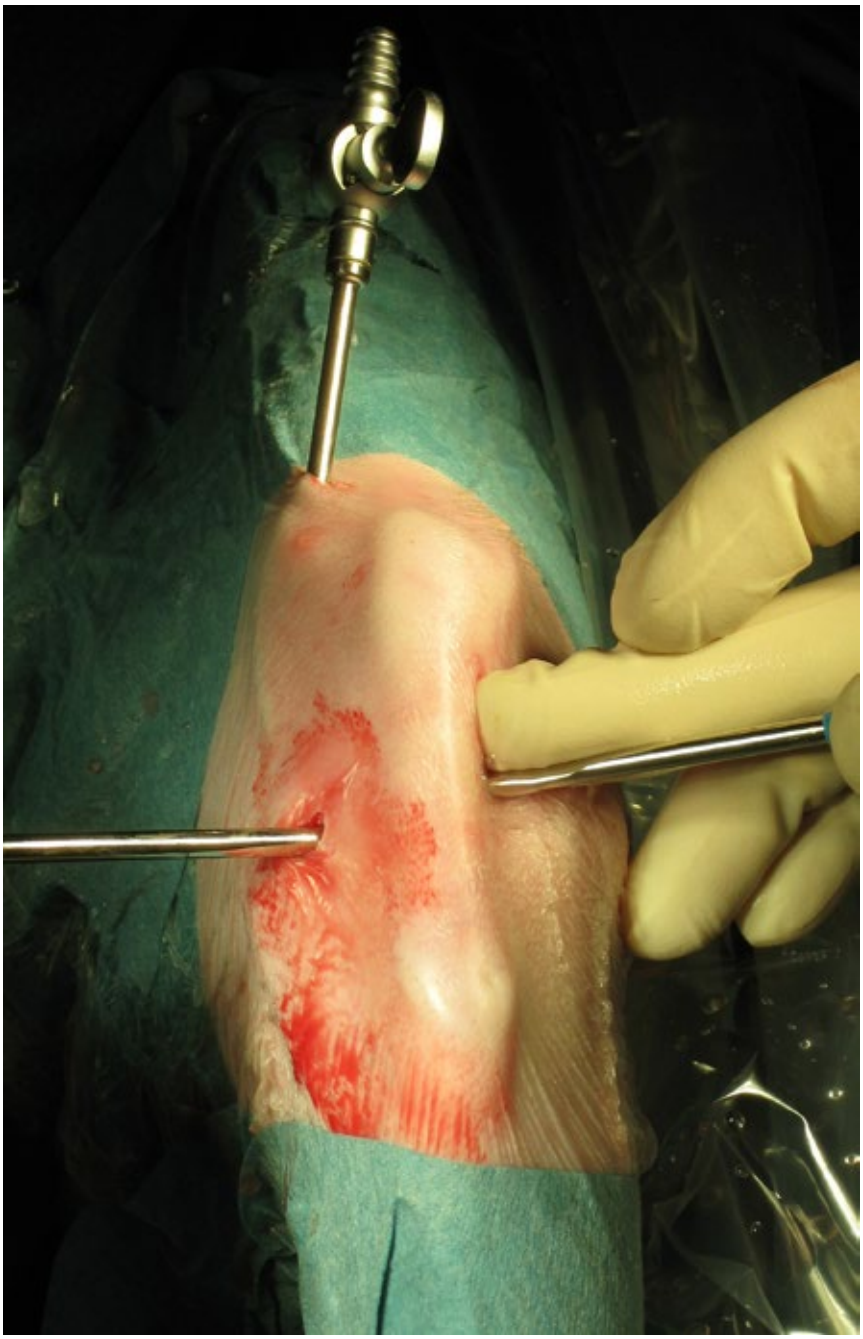

FIGURE 2 KUVA

Routine stifle joint arthroscopic portals were used for arthroscopic lavage of the left stifle joint. Inflow cannula for fluids and for the scope (2.7 mm 30° oblique telescope) was placed lateral to the patellar tendon. Two outflow cannulas were introduced medially into the proximal patellar pouch and medial to the patellar tendon.
Vasemman polvinivelen tähystysavusteinen nivelhuuhtelu tehtiin käyttäen tavanomaisia niveltähystysportteja. Nestevirtauskanyyli ja niveltähystin (2.7 mm 30° viisto optiikka) vietiin niveleen polvilumpion suoran siteen ulkosivulta. Nesteen ulosvirtauskanyyleistä toinen pistettiin nivelen sisäsivulle polvilumpion yläpuoliseen nivelpussiin ja toinen polvilumpion suoran siteen kohdalle nivelen sisäsivulle.

day 4 after presentation, the dog was bright but still 3/ 4 lame in the left hind limb. The total nucleated cell count of the synovial fluid had increased to 178.0 x 10^9/ l, but the proportion of neutrophils had decreased to 91.5%. The C-reactive protein (CRP) concentration in the blood was 20 mg/ l (reference <10 mg/ l). Arthroscopic lavage was repeated. Intravenous medications, as well as gabapentin, were continued.

On day 6, the total nucleated cell count had diminished to 67.2 x 10^9/ l, with 93.5% neutrophils and 6.5% mononuclear cells. Arthroscopic lavage was repeated.

On day 8, the total nucleated cell count was only 18.1 x 10^9/ l in the joint fluid, with 94.5% neutrophils and 5.5% mononuclear cells. The joint was arthroscopically visualized. The crushed and cranially dislodged caudal part of the medial meniscus was removed by using a 3.5 mm arthroscopic shaver. All the implants from the former TTA surgery and the lateral sutures were removed to eliminate the risk of the implants acting as a nidus for infection (figure 1B). Finally, the joint was lavaged with 5000 ml of sterile saline.

The dog was discharged from the hospital on day 10. Medications at home included cephalexin 24 mg/ kg three times a day, enrofloxacin 7 mg/ kg twice a day, tramadol 1–2 mg/ kg one to three times a day, gabapentin 10 mg/ kg twice a day and meloxicam 0.1 mg/ kg once a day.

At the control visit on day 12, the dog was doing clinically moderately well. However, the lameness score for the left hind limb was still 3/ 4. The stifle joint was painful both in extension and flexion, but no effusion was noted. The body temperature was 38.1 °C and CRP was 13 mg/ l. The bacterial cultures from the screws and the nylon sutures removed from the joint showed no bacterial growth.

A week after implant removal (day 19), the dog presented with acute non-weight-bearing lameness. Radiographs revealed a fracture of the tibial tuberosity (figure 1C). Joint fluid analysis showed a total nucleated cell count of 6.2 x 10^9/ l, with 77% neutrophils and 23% mononuclear cells and a total protein concentration of 31 g/ l. The fracture was repaired using implants and an autogenous full-thickness bone block from the ilium to maintain the advancement of the original TTA operation (figure 1D). Medication was continued as before.

Two weeks later (day 33), the dog was bright and the lameness score was 1/ 4. Antibiotic medication was discontinued. The dog's static weight bearing was 6 kg and 11 kg for the left and right hind limb, respectively, and circumference of the thigh was 43 cm and 46 cm for left and right, respectively. Manual physiotherapy and water treadmill exercises were instituted.

Continuous progression of healing could be seen in follow-up radiographs obtained at 1, 2 and 4 months post-operatively. Osteoarthritic changes did not increase. At the control visit after 4 months, the dog was no longer lame and the static weight bearing and the thigh circumference had improved. The passive range of motion in the left and right stifle joints were 30–150° and 20–160°, respectively. Normal exercise was allowed.

At the 1-year follow-up visit, we saw no signs of infection and the dog was no longer lame. The dog was able to sit with both stifles flexed in a normal position. The functional and radiographic outcome was good.

DISCUSSION

Septic arthritis is detrimental to the joint and potentially a life-threatening condition. In our case the septic arthritis could have been a consequence of the TTA or lateral suture operations or intra-articular injections. Arthroscopic lavage combined with intravenous antibiotics and removal of the implants proved to be an effective treatment, in which clinical presentation, joint fluid cytology and bacterial culture confirmed the diagnosis of septic arthritis. Arthroscopic intervention of septic arthritis has previously proven successful in humans and horses,[12-15] and should be encouraged in canine medicine.

The treatment of bacterial arthritis aims at preserving cartilage and the earlier pain-free range of motion of the limb. Optimal treatment includes antibiotic therapy and surgical treatment, mainly joint lavage. The joint lavage can be performed by irrigation with large-bore needles, arthroscopically, via arthrotomy or, in some cases, by continuous drainage.[1] In humans, 91–100% of the infected joints improve with arthroscopic lavage and systemic antibiotic therapy.[13-15] In contrast, in another human study, fever lasted longer in patients treated with needle irrigation and they needed intravenous antibiotic therapy longer than those treated arthroscopically.[16] Further, a recent study on foals demonstrated that needle irrigation is not sufficient to resolve the infection.[12] Arthroscopic lavage is superior to joint irrigation performed through a needle, because it allows large volumes of fluid to be used and the fluid can be directed to the joint recesses. Arthroscopically, it is possible to remove larger particles and fibrinous material and to perform synovectomy to reduce the number of bacteria lodged in the synovial tissue.[5] Arthroscopic lavage is repeatable, causes less postoperative morbidity and allows visualization of the cartilage than open arthrotomy.[1,5,17] Arthrotomy causes greater tissue injury, which predisposes to surgical site infection. Furthermore, with open arthrotomy, all joint recesses cannot be thoroughly lavaged.[18] Since our previous attempts to treat septic arthritis with needle irrigation or arthrotomy did not produce satisfactory outcomes, we used arthroscopic intervention, which is common practice in equine medicine and strongly encouraged in humans.

Arthroscopic surgery of the stifle joint is performed by using the craniolateral portal and two medial portals.[19] These portals have also been used for arthroscopic lavage. To our knowledge, the optimal volume of fluid needed for sufficient irrigation or the sufficient number of arthroscopic lavages have not been determined. The number of treatments should correspond with the severity of the initial infection and the clinical response.[13] Arthrocentesis and examination of joint fluid cytology are usually repeated at intervals of a few days. If needed, arthroscopic lavage is repeated.[7] In foals with a septic coxofemoral joint, arthrocentesis is repeated 2–6 days after the first lavage and the arthroscopic lavage is repeated 1–3 times.[12] In two human studies, the arthroscopic lavage was repeated a median of three times.[7,14] In our case, we took joint fluid samples at 2–3-day intervals and lavaged the joint four times.

In addition to lavage, optimal treatment includes systemic antimicrobial therapy. Benzioni et al suggested that systemic antibiotics alone are effective, but the response can be slow and their study included no control group.[20] The suggested duration of antimicrobial treatment is at least 28 days.[1,3] One human study recommends 4–6 weeks, with intravenous administration in the first 2–3 weeks.[16] However, in another study, well-absorbed antimicrobials were given for less than 2 weeks and the duration was considered sufficient.[21] Our patient received intravenous antimicrobials for 1 week followed by oral antimicrobial therapy for 3 weeks. While bacterial culture and sensitivity results are pending, an empirically chosen antibiotic, such as a first-generation cephalosporin, should be used. As soon as complete bacteriological results are available, treatment should be adjusted accordingly. We should have discontinued enrofloxacin therapy as soon as the result of a cephalexin-susceptible *Staphylococcus aureus* was confirmed. Intra-articular antibiotics can be considered when systemic antibiotic therapy and surgical intervention are insufficient to resolve the infection.[17] In contrast, intravenous administration of antibiotics in humans produces sufficient concentrations in the synovial fluid, which makes intra-articular therapy unnecessary.[13]

Implants are recommended to be removed if signs of contamination are seen, if they are no longer functional or if signs of infection persist, despite adequate treatment. In our case, we decided to remove the implants, when we saw bone lysis in radiographs (figures 1A and 1B). Additionally, the lateral suture did not provide anatomical stabilization after the TTA operation and thus did had no clinical relevance. Although the fork of the TTA could be detached easily and there was grayish discharge coming from the holes, bacterial culture of the implants was negative. The negative culture can be due to several days of intravenous antibiotic therapy before culture and to the fact that implants were extra-articular.

We considered the left stifle joint unstable after the TTA surgery. Osteotomy techniques rely on change in mechanics of the stifle joint. The stifle joint will be dynamically stabilized by muscle forces after the surgery.[22] Osteotomy techniques in cruciate ligament surgery do not aim for passive stabilization of the joint, in contrast to the techniques that replace the cruciate ligament, such as the lateral suture. However, recent research suggests that stabilization of the stifle joint is not reliably achieved with the lateral suture

technique.[23] Therefore, the second operation to stabilize the joint by lateral suture was in vain. Meniscal damage is reported to occur in 5.8–27.8% of patients after TTA surgery in cruciate ligament deficient joint.[24,25] Treatment for the damaged meniscus would have been removal of the damaged part of the meniscus after the first operation.

The end result for the degree of lameness after treated septic arthritis depends on the pre-existing problem in the joint. Bacterial arthritis causes cartilage damage, which worsens the underlying problem. The initial severity of the infection has an impact on the treatment response and outcome.[11,13] Early diagnosis and treatment can preserve the joint from arthritic degeneration.[11,15]

Untreated septic arthritis is devastating to the joint cartilage and synovial membrane. Arthroscopic intervention of septic arthritis has been proven to be superior to other treatment options in other species. It was also effective in our canine case, when combined with intravenous antibiotic therapy and implant removal. Arthroscopic irrigation is encouraged to be considered when treating septic arthritis. Future studies on the optimal protocol for arthroscopic treatment of septic arthritis in dogs are needed.

REFERENCES

1. Innes JF. Arthritis. In: Tobias KM, Johnston SA, ed. Veterinary surgery: Small Animal. St. Louis, Elsevier Saunders 2012, 1078-111.
2. Marchevsky AM, Read RA. Bacterial septic arthritis in 19 dogs. Aust Vet J. 1999;77:233-7.
3. Clements DN, Owen MR, Mosley JR, Carmichael S, Taylor DJ, Bennett D. Retrospective study of bacterial infective arthritis in 31 dogs. J Small Anim Pract. 2005;46:171-6.
4. Bennett D, Taylor DJ. Bacterial infective arthritis in the dog. J Small Anim Pract. 1988;29:207-30.
5. Fearnside SM, Preston CA. Arthroscopic management of septic polyarthritis in a dog. Aust Vet J. 2002;80:681-3.
6. Ridge PA. A retrospective study of the rate of postoperative septic arthritis following 353 elective arthroscopies. J Small Anim Pract. 2011;52:200-4.
7. Abdel-Aziz A, Radwan YA, Rizk A. Multiple arthroscopic debridement and graft retention in septic knee arthritis after ACL reconstruction: a prospective case-control study. Int Orthop. 2014;38:73-82.
8. MacWilliams PS, Friedrichs KR. Laboratory evaluation and interpretation of synovial fluid. Vet Clin North Am Small Anim Pract. 2003;33:153-78.
9. Scharf VF, Lewis ST, Wellehan JF, Wamsley HL, Richardson R, Sundstrom DA et al. Retrospective evaluation of the efficacy of isolating bacteria from synovial fluid in dogs with suspected septic arthritis. Aust Vet J. 2015;93:200-3.
10. Montgomery RD, Long IR, Milton JL, DiPinto MN, Hunt J. Comparison of aerobic culturette, synovial membrane biopsy, and blood culture medium in detection of canine bacterial arthritis. Vet Surg. 1989,18:300-3.
11. Smith RL, Schurman DJ, Kajiyama G, Mell M, Gilkerson E. The effect of antibiotics on the destruction of cartilage in experimental infectious arthritis. J Bone Joint Surg Am. 1987;69:1063-8.
12. Barceló Oliver F, Russell TM, Uprichard KL, Neil KM, Pollock PJ. Treatment of septic arthritis of the coxofemoral joint in 12 foals. Vet Surg. 2017;46:530-8.
13. Stutz G, Kuster MS, Kleinstuck F, Gachter A. Arthroscopic management of septic arthritis: stages of infection and results. Knee Surg Sports Traumatol Arthrosc. 2000;8:270-4.
14. Gille J, Gerlach U, Oheim R, Hintze T, Himpe B, Schultz AP. Functional outcome of septic arthritis after anterior cruciate ligament surgery. Int Orthop. 2015;39:1195-201.
15. Monaco E, Maestri B, Labianca L, Speranza A, Vadalá A, Iorio R et al. Clinical and radiological outcomes of postoperative septic arthritis after anterior cruciate ligament reconstruction. J Orthop Sci. 2010;15:198-203.
16. Wang C, Ao Y, Wang J, Hu Y, Cui G, Yu J. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: a retrospective analysis of incidence, presentation, treatment, and cause. Arthroscopy 2009;25:243-9.
17. Hewes CA, Macintire DK. Intra-articular therapy to treat septic arthritis in a dog. J Am Anim Hosp Assoc. 2011;47:280-4.
18. Johns BP, Loewenthal MR, Dewar DC. Open compared with arthroscopic treatment of acute septic arthritis of the native knee. J Bone Joint Surg Am. 2017;99:499-505.
19. Whitney WO. Arthroscopically assisted surgery of the stifle joint. In: Beale BS, Hulse DA, Schulz KS, Whitney WO, eds. Small Animal Arthroscopy. Philadelphia, Saunders 2003, 117-57.
20. Benzioni H, Shahar R, Yudelevitch S, Milgram J. Bacterial infective arthritis of the coxofemoral joint in dogs with hip dysplasia. Vet Comp Orthop Traumatol. 2008;21:262-6.
21. Peltola H, Pääkkönen M, Kallio P, Kallio, MJT. Prospective, randomized trial of 10 days versus 30 days of antimicrobial treatment, including a short-term course of parenteral therapy, for childhood septic arthritis. Clin Infect Dis. 2009;48:1201-10.
22. Tepic S, Damur DM, Montavon PM. Biomechanics of the stifle joint. 1st World Orthopaedic Veterinary Congress; Munich, Germany. 2002, 189–90.
23. Fischer C, Cherres M, Grevel V, Oechtering G, Böttcher P. Effects of attachment sites and joint angle at the time of lateral suture fixation on tension in the suture for stabilization of the cranial cruciate ligament deficient stifle in dogs. Vet Surg. 2010;39:334-42.
24. Wolf RE, Scavelli TD, Hoelzler MG, Fulcher RP, Bastian RP. Surgical and postoperative complications associated with tibial tuberosity advancement for cranial cruciate ligament rupture in dogs: 458 cases (2007-2009). J Am Vet Med Assoc. 2012;240:1481-7.
25. Hirshenson MS, Krotscheck U, Thompson MS, Knapp-Hoch HM, Jay-Silva AR, McConkey M et al. Evaluation of complications and short-term outcome after unilateral or single-session bilateral tibial tuberosity advancement for cranial cruciate rupture in dogs. Vet Comp Orthop Traumatol. 2012;25:402-9.

AUTHORS

Aija Mehtälä, DVM
Private Small Animal Clinic Pet-vet, Biolinja 20, 20750 Turku, Finland, aija.mehtala@petvet.fi

Artikkeli on osa kirjoittajan erikoistumiskoulutusohjelmaa.

Katariina Thomson, DVM, PhD
Veterinary Teaching Hospital, Faculty of Veterinary Medicine, University of Helsinki
Pauli Keränen, DVM, PhD
Department of Equine and Small Animal medicine, Faculty of Veterinary Medicine, University of Helsinki