Treatment of an infected total knee replacement with two-stage arthrodesis in a dog: a case report

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ABSTRACT: A three-year-old intact female Great Pyrenees underwent total knee replacement for the treatment of osteoarthritis. The dog contracted septic arthritis 10 weeks following the procedure. Treatments including implant subtraction, debridement of tissue, and insertion of bone cement with antibiotics into the joint space were completed in the joint cavity. A temporary external skeletal fixator was used to stabilise the joint for four weeks. A second attempt at total knee replacement failed due to severe muscle contracture and bone loss. Therefore, it was decided to perform arthrodesis as a salvage procedure. At the 17 month follow-up examination, the patient was able to use the limb while standing and at all gait speeds. Based on these findings, two-stage arthrodesis can be a viable salvage procedure for infected total knee replacements.

Keywords: total knee replacement; arthrodesis; infection; dog

Total knee replacement is a surgical procedure that replaces the weight bearing surfaces of the knee joint with prosthetic implants. Total knee replacement can improve quality of life by relieving pain and improving joint motion. In human medicine, total knee replacement is a gold standard treatment for end stage osteoarthritis. Currently, over 600 000 human patients undergo total knee replacement annually worldwide (Paxton et al. 2008). The clinical success rates are high, with > 95% of patients reporting no failure. In veterinary medicine, total knee replacement has recently been performed in canine patients with end stage osteoarthritis (Allen et al. 2009; Liska and Doyle 2009). The outcomes of total knee replacement in dogs include significantly improved joint function. However, more clinical studies are needed to comprehensively evaluate the actual functional outcomes of total knee replacement in the dog.

Complications of total knee replacement include misalignment of the implant, joint stiffness, implant loosening, and infection (Riaz and Umar 2006). Infection following total knee replacement is the most challenging complication. Several first options for the treatment of infected total knee replacements include antibiotic suppression, irrigation and debridement with component retention, and one-stage or two-stage implant exchange. However, if the first attempts fail, the final option is amputation or arthrodesis (Garvin and Konigsberg 2011).

For successful arthrodesis in a dog with an infected total knee replacement, two things should be considered above all: how to eradicate the infection and how to get maximum bone contact between the femur and tibia for bone union in situations of bone loss due to previous total knee replacement surgery and debridement of bone to eradicate infection. Although surgical arthrodesis in dogs has been described in several reports, to our knowledge, there are no known case reports addressing arthrodesis in a dog with an infected total knee replacement. The purpose of this report is to describe the surgical planning, procedure, and outcome of two-stage arthrodesis for the treatment of an infected total knee replacement in a dog.

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Case description

A three-year-old, 27 kg, intact female Great Pyrenees presented with left hind limb lameness and was diagnosed with cranial cruciate ligament deficiency. A tibial wedge ostectomy was performed to treat the stifle joint instability. However, lameness continued for six months after treatment. Arthroscopy and radiographs showed moderate osteoarthritis. Finally, total knee replacement was performed that included tibial ostectomy (tibial cut) along with four femoral cuts (cranial, caudal, distal, and cranio-distal). After completing the tibial and femoral cuts, a trial reduction was performed with trial tibia and femoral components. A tibial component of appropriate thickness was then selected to obtain equal tension balance on the collateral ligament. After removal of the trial components, bone cement was placed on the proximal tibia. The tibial implant was then cemented into place. A femoral implant was seated securely into the femoral cut surfaces using an impactor (Figure 1). After total knee replacement surgery, the patient's gait improved slowly and the range of stifle joint motion showed progressive improvement in the affected limb. However, the gait became worse and joint effusion and decreased joint motion was observed 10 weeks after total knee replacement surgery (Table 1). Synovial fluid from the affected stifle joint was taken for bacterial culture and antibiotic sensitivity tests. Culture of the synovial fluid yielded coagulase-positive *Staphylococcus* that was susceptible to amikacin, enrofloxacine, gentamycine and amoxicillin with clavulanic acid. To treat the infection, a cranialolateral approach to the stifle joint was performed through a previous incision. Extensive yellow colouring of the synovium, a thin biofilm on the implant, and loosening of the tibial component were noted during surgery. The prosthetic components and all of the bone cement were removed and debridement was performed with multiple lavages. Bone cement was shaped into a hockey puck-like joint spacer with gentamycine and inserted into the joint cavity. The joint and

Figure 1. Postoperative radiographs two weeks after total knee replacement. The plate and screws for the tibial wedge ostectomy were removed when total keen replacement was performed. A = lateral view, B = cranio-caudal view

subcutaneous tissues were closed routinely. A temporary external skeletal fixator (ESF) was used to stabilise the stifle joint (Figure 2). The skin-implant interfaces of ESF were cleaned with a 0.05 % chlorhexidine sponge, and sterile sponges were packed between the pins and skin. Two weeks following surgery, subluxation of the antibiotic bone cement was noted. However, no clinical complications resulted from this problem. Amikacin (11 mg/kg *i.m.* every 12 h), enrofloxacin (10 mg/kg *p.o.* every 12 h) and tramadol (2 mg/kg *p.o.* every 12 h) were administered for four weeks. After completion of antibiotic therapy, the patient was observed for one week. At that time, the culture results of aspirated joint fluid were negative and there was no clinical evidence of recurrent infection. Five weeks after surgery, revision total knee replacement surgery was attempted. However, this procedure failed due to severe muscle contracture and bone loss which made it impossible to insert total knee replacement implants. Therefore, arthrodesis using bone plates and screws was decided upon as a salvage procedure. Irregular bone surfaces on the femur and tibia

Table 1. Range of stifle joint motion after total knee replacement

	Preoperative	Postoperative	2 weeks	6 weeks	10 weeks
Flexion (°)	43	45	48	45	50
Extension (°)	140	148	145	150	130
Excursion (°)	97	103	97	105	80

Figure 2. Craniocaudal radiograph after removal of the prosthesis and implantation of an antibiotic impregnated bone cement spacer. The stifle joint was stabilized with temporary external skeletal fixator. The medially displaced patella is denoted by an arrow

were gently removed to obtain maximum bone contact using an electronic burr. Reaming of the medullar canals was completed through the sclerotic

Figure 3. Lateral radiograph 10 weeks after arthrodesis

Table 2. Comparison between the arthrodesed limb and contralateral limb at 17 months

Variable	Arthrodesed limb		Contralateral limb	
Stifle joint angle while standing (°)	125		121	
Bone length* (%)	femur	tibia	femur	tibia
	93	93	100	100
Tight girth* (%)	94		100	

The difference in bone length is measured between the arthrodesed limb and contralateral limb on craniocaudal radiographs
*expressed as a percentage of the contralateral limb

bone area using a 2 mm drill bit. Transarticular pins were inserted across the joint to help maintain the 135° angle of the stifle joint. A dynamic compression plate was placed along the cranial aspect of the femur and tibia to stabilise the stifle joint. Cancellous bone harvested from the greater tubercle of the left humerus was placed into the arthrodesis site. On postoperative radiographs, the final angle of the arthrodesis was 125°. Three weeks postoperatively, the patient's gait was intermittent non-weight bearing. Gradual improvement of gait was observed. Substantial weight-bearing ambulation was observed at eight weeks after surgery. Ten weeks after surgery, bone union was observed without any complications (Figure 3). From 10 weeks onward, the patient was allowed 15 min of unrestricted walking per day. At the 17 month follow-up orthopaedic examination, the patient was observed to use the limb while standing and at all gait speeds. However, the angle of the tarsal joint on the arthrodesed limb was hypoextended in comparison to the contralateral limb in the standing position. Thigh girth measurement for the affected limb was 94% of the contra-lateral limb (Table 2).

DISCUSSION AND CONCLUSIONS

Infection after total knee replacement is a challenging and difficult problem to treat. Whatever decision surgeons make, such as revision surgery and arthrodesis, eradication of the infection should be completed first. Treatment options for infection include antibiotic suppression, one-stage procedures and two-stage procedures. Antibiotic suppression can be applied if the implant is stable and the microorganism has low virulence and is susceptible to oral

antibiotics. However, the reported infection eradication rate of this approach is only 6% (Bengston et al. 1989). One-stage techniques include implant subtraction, debridement, copious irrigation, and revision total knee replacement surgery or arthrodesis. A systemic antibiotic is given for six to 12 weeks and the reported infection eradication rate is 89% (Silva et al. 2002). Two-stage techniques include the removal of all implants and cement, thorough debridement, and irrigation followed by implantation of antibiotic bone cement spacer, which releases antibiotics locally at high concentrations. Systemic antibiotics are given for four to eight weeks. If there is no clinical sign of infection, total knee replacement revision surgery or arthrodesis can then be performed. The reported infection eradication rate is 92% (Hofmann et al. 2005).

There is debate regarding the relative merits of one-stage or two-stage techniques. However, many authors have advocated two-stage procedures if a patient has late chronic infection that developed > 4 weeks after surgery. In the present case, the infection was treated successfully with a two stage technique. After treatment of the infection, we attempted revision total knee replacement. That failed because of severe muscle contracture and bone loss, which made it impossible to insert the total knee replacement implants. This failure may have been caused by the subluxation of the antibiotic bone cement spacer. Such a situation can lead to arthrofibrosis and contracture of the extensor mechanism. The subluxation of antibiotic bone cement spacer is more frequently observed after placement of static spacers rather than articular spacers (Fehring et al. 2000). In our case, we used a static spacer and temporary ESF was then applied to maintain the joint space and to reduce the risk of subluxation of the bone cement. However, this approach did not work well.

Arthrodesis can be used as a salvage procedure if revision total knee replacement fails, in the case of infection caused by a highly virulent microorganism, or when the extension function of the knee is deficient (Incavo et al. 2000; David et al. 2001; Gore and Gassner 2003). For successful arthrodesis, maximum bone contact and limb length are important factors. Maximum bone contact surface can lead to better bone fusion at the arthrodesis site. The functionality of the limb is related to limb length sufficient to allow the paw to touch the ground while standing. Shortening limb length caused by femoral and tibial osteotomies may be prevented if the arthrodesis angle is increased 5 to 10 degrees to compensate (Cofone et al. 1992). In this case, the patient had an irregular bone surface and bone loss from the previous total knee replacement surgery and debridement of the bone to eradicate infection. Therefore, we ensured maximum bone contact without significant bone shorting when the irregular bone surface was flattened. After this was accomplished, reaming of the medullar canals on the sclerotic bone and cancellous bone grafts was performed to aid bone union. The length of the femur and tibia together was 7% shorter in comparison to the contralateral limb. In addition, the final angle of arthrodesis was 125° despite the optimal angle arthrodesis being 135°. However, the length of the arthrodesis-treated limb allowed the paw to touch the ground in a standing position. The shortened limb length may have been compensated for by flexion of the stifle joint in the contralateral limb and hypoextension of the tarsal joint in the arthrodesed limb.

In summary, arthrodesis can be successfully performed after infected total knee replacement as a salvage procedure. Two-stage arthrodesis in an infected total knee replacement can provide acceptable limb function. However, the function of limb will not be normal due to a loss of stifle joint motion.

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