Infection in total joint replacement continues to be a challenging and controversial topic. Treatment is expensive and often ineffective, especially in cases with multiple bacterial species or resistant organisms. An effective single-stage operation that enables patients to be mobilized and treated at home would be a major advance in the treatment of this disease.

The standard technique for treating infected total joints currently is performed in two surgical stages. Implant removal, joint debridement, and treating the joint locally with an antibiotic-loaded cement spacer generally are done first and then are followed by joint revision with new implants and antibiotic-loaded cement several weeks later. The high failure rate is due possibly to the relatively low concentration of antibiotics that can be achieved in the joint. Also, the cement spacer can harbor bacteria, which may result in recurrent infection and resistant organisms. Direct delivery of antibiotics into the joint, however, provides high local concentration of antibiotics that can be maintained for weeks or months, and also achieves therapeutic serum levels. In a preliminary study done in 2000, antibiotic levels 100-500 times higher than could be achieved intravenously were found in the knee, and therapeutic levels of antibiotics were found in the serum following the direct infusion of antibiotics into the joint.

This article describes a new treatment method and presents the early results of infected total joint arthroplasty using single-stage revision with cementless total joint replacement components, and direct antibiotic infusion into the joint.

MATERIALS AND METHODS

Since 1999, 31 patients have been treated with a direct noncemented component exchange with antibiotics infused directly into the joint via Hickman catheters. The treatment protocol includes a single-stage surgery in which the components are removed, the joint is debrided thoroughly, new porous-coated components are implanted without cement or bone graft, and two indwelling single lumen Hickman catheters are placed.

After debridement and reimplantation, the Hickman catheters are inserted percutaneously. A long, thin, curved clamp is passed from inside the joint through a layer of periaricular muscle and to the skin. The clamp is opened gently to dilate the soft tissue. The tip of the clamp is passed through the wound. The wound is kept as small as possible to allow the skin to seal around the catheter. The clamp is inserted gently to dilate the soft tissue. The tip of the catheter is placed deep to the dermis, but not in the muscle. Each catheter is secured with two silk sutures. The sutures are carefully released from the skin after 2 weeks, but left attached to the catheters to avoid damage to the catheters during suture removal. The patient then receives organism-specific intra-articular antibiotics through the Hickman catheters for 6 weeks.

Because of the potential toxic effects of antibiotics such as vancomycin and aminoglycosides, serum peaks and troughs are monitored for the first 3-4 days, followed by biweekly trough serum levels until treatment is ended. The intra-articular antibiotic dose is
adjusted to maintain safe and therapeutic peripheral levels. For vancomycin infusions trough serum levels are maintained between 5 μg/mL and 12 μg/mL. Serial dilution in normal saline demonstrated that the maximum concentration of vancomycin that will not precipitate in vitro is 100 mg/mL (500 mg in 5 mL). If vancomycin is used, the initial dose is 500 mg in 10 mL of normal saline twice daily. In patients with renal impairment, the dose is decreased to 250 mg in 5 mL. The same antibiotics used in the irrigation solution during surgery should be infused into the joint to avoid precipitation.

RESULTS

Two (6%) of 31 cases failed, resulting in a 94% success rate. One failure occurred in a patient in whom adequate soft-tissue coverage could not be achieved despite multiple surgical attempts, and the second failure occurred in a patient who initially was treated at another institution and the infecting organism was never identified. He subsequently underwent a hip disarticulation.

Two patients developed local complications secondary to vancomycin infusion. One patient developed a draining wound following revision of a total knee replacement. The drainage consisted of serosanguineous fluid with precipitated vancomycin particles. Joint aspirations were negative for infection. The drainage resolved after stopping the intra-articular antibiotic infusions. Another patient initially presented with right lower lobe pneumonia and a septic total hip. Revision surgery included removal of the infected components and cement, thorough debridement, and insertion of cementless revision components and two Hickman catheters. Intra-articular vancomycin was infused for 6 weeks to treat the infected hip, and intravenous piperacillin/tazobactam was given for the first 2 weeks to treat the pneumonia. Serum levels of vancomycin were maintained around 4.5-5 μg/mL. Induration, swelling, and discoloration of the incisional area were noted 5.5 weeks postoperatively, but the hip was not painful with passive and active motion. Aspirated hip fluid had a white blood cell count of 22,000 cells, and the cultures remained negative. Vancomycin infusion was stopped and the local inflammation resolved over the next week. The combination of intravenous piperacillin and intra-articular vancomycin was suspected to have induced precipitation of the vancomycin, leading to an acute sterile inflammatory response that resolved after the vancomycin was discontinued.

DISCUSSION

Complete eradication of bacteria from the joint is necessary to cure infected total joint arthroplasty. Most infected cases are cemented and harbor bacteria in the bone-cement interface and on the surfaces of the metal and cement. Implant removal, thorough debridement, and delivery of high concentrations of antibiotics for a prolonged period of time are necessary to achieve a high success rate in these cases. The current technique was developed to avoid the known pitfalls of antibiotic-loaded cement, which delivers antibiotics only for a few days and can harbor resistant bacteria on its surface. Directly infusing antibiotics into the infected area maintains a high local concentration level while minimizing systemic toxicity. Resistant bacteria absorb antibiotics when a very high local level is obtained, and the high intracellular levels achieved overcome many resistance mechanisms. Local antibiotic delivery of amikacin using an implantable pump was successful in treating 71% of patients with chronic recalcitrant osteomyelitis, and salvaged 18 of 20 infected total joint arthroplasties.

Because of the high local concentration of intra-articular antibiotics, compatibility of all intra-articularly and systemically administered antibiotics must be evaluated before and during treatment. Local vancomycin concentrations 50-2095 μg/mL have been reported, and in vitro testing has demonstrated that vancomycin will precipitate rapidly when mixed with small amounts of cephalosporins, clindamycin, and penicillins. If this occurs in vivo, wound drainage or clinical signs of local inflammation can occur.

CONCLUSION

This is an early report of the treatment of septic prosthetic joints using a single-stage non-cemented revision with intra-articular antibiotic infusion. The 94% success rate is comparable to success rates reported in the literature for delayed-exchange arthroplasty using antibiotic loaded cement. It has the potential to avoid the morbidity associated with multiple surgeries and prolonged immobility.

REFERENCES