

Review

Two-stage procedure in the treatment of late chronic hip infections - spacer implantation

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Abstract

Infection after total hip arthroplasties (THA) is a devastating complication with significant consequences for both the patients and the healthcare systems. In recent times, a two stage procedure using antibiotic-impregnated interim spacers has become the most popular treatment for late chronic hip joint infections after THA with success rates over 90%. In this review, we discuss the different types of spacers used in the treatment of chronically infected THA and conclude that hip spacers are effective in the treatment of hip joint infections.

Key words: Total hip arthroplasty; infection; treatment; spacers; antibiotic loaded cement

Introduction

Periprosthetic infection after THA is a catastrophic complication which presents an enormous challenge to the orthopaedic community. Diagnosis is often difficult as no gold standard test is available; thus, the diagnosis relies on the surgeon's judgement of the clinical presentation, the findings on physical examination and the interpretation of relevant investigations. The treatment goals are to attempt limb salvage and preserve joint function in an aging population with multiple co-morbidities and high risk of developing perioperative complications. Late chronic hip infections have been defined as those presenting more than 4 weeks from surgery, as opposed to acute infections occurring within 4 weeks of the operation [1].

Treatment of Chronic Hip Infections after THA

Treatment options for chronic hip joint infections after THA have evolved from a single-stage direct exchange to two-stage and more recently multi-stage

revision arthroplasty in several centres. The dilemma of identifying which patients are suitable for single versus multi stage revision remains unresolved. Long term suppressive antibiotics and salvage procedures such as girdlestone arthroplasty, arthrodesis and amputation have also been used in patients with high operative risk and in patients who are unwilling to have additional procedures.

While single-stage revision has had good results[2-4], two-stage reimplantation remains the gold standard for the treatment of chronically infected THA today as the successful eradication of infection is well over 90% [5,6]. Furthermore, it permits un cemented reconstruction and the use of allografts at the second-stage which is particularly important given the frequency of femoral and acetabular defects associated with THA infections [7-9].

The aim of a two-stage revision is to eradicate any residual bacteria after removal of the prosthesis and meticulous surgical debridement at the first-stage, followed by identification of the infecting

organism from tissue biopsies, determination of antibiotic sensitivity and appropriate adjustment of systemic antibiotic therapy before reimplantation.

The timing of the second stage is variable but is essentially based on clinical, radiological and laboratory evidence that infection has been overcome with an ESR and CRP levels returning to normal values.

Antibiotic Loaded Cement

The use of antibiotic loaded cement (ALC) in the form of spacers during the interval period to deliver antibiotics locally has become popular as it has increased rates of infection control achieving up to 95% in several studies [10-12]. A number of papers have established the capability of ALC to deliver a much greater local concentration of antibiotic than is possible by systemic therapy [13-17] whilst preventing debris from accumulating in the potential joint space and decreasing the risk of soft-tissue contractures [18]. Recent studies [19] suggest that the ALC may remove the need for systemic antibiotics in the interval period, thus decreasing costs and morbidity.

Palacos bone cement has been widely used because of its superior elution characteristics and resistance to fracture in comparison with other cement types [20,21]. However, Ensing et al [22] in a recent study showed that Copal bone cement has better release of gentamicin and may therefore be more effective in preventing biofilm formation than Palacos.

When mixing the cement with antibiotics, it is important to leave as many large crystals intact as possible to create a more porous mixture to increase the antibiotic elution rate and apply the cement in the late stage of polymerisation to prevent interdigitation into bone to facilitate extraction at the 2nd stage revision [23]. Vacuum mixing whilst increasing the mechanical strength of cement by decreasing porosity, may also decrease antibiotic elution rates [15].

Antibiotics added to bone cement are chosen according to the sensitivity of the infecting organism but conventionally have to fulfil the criteria established by Murray [24] including: antibiotic safety, thermostability, hypoallergenicity, water solubility, adequate bactericidal spectrum and availability in a sterile powder form. The addition of antibiotics dissolved in liquid decreases the mechanical properties of the ALC which may increase the possibility of spacer fractures. Hsieh et al [25], however; followed up 42 patients undergoing two-stage revision arthroplasty for periprosthetic infection recently and concluded that incorporation of liquid gentamicin in bone cement spacers led to effective drug delivery with systemic safety. The most commonly used antibiotics in ALC include tobramycin, gentamicin and vanco-

mycin [26]. The combination of vancomycin and one of the aminoglycosides provides a broad spectrum of coverage for organisms commonly encountered with deep periprosthetic infections whilst reducing the development of resistant strains [27]. Staphylococci in particular, rapidly develop resistance and therefore; single antibiotic treatment should never be used [28]. It is also important to keep in mind that if ALC had been used for the primary procedure, bacteria causing the infection may have already survived high concentrations of that antibiotic and will likely be resistant if the same antibiotic is used in the spacer cement [29].

When used in temporary spacers, antibiotic dosages up to 20 g per 40 g of bone cement can be achieved without reported systemic side effects [30] whereas for fungal infections, 100 to 150 mg of amphotericin B is typically added to the 40 g of bone cement in addition to other antibiotics chosen [31]. Mechanical strength of cement however; is influenced by the ratio in which the antibiotics are mixed into the cement and therefore, the total dose of antibiotics should not exceed 10% of the weight of the cement in order to avoid fracture of the cement spacer [27].

The implantation of an ALC spacer shortens the duration of systemic antibiotic therapy which lessens the likelihood of systemic toxicity and may result in a reduction in the emergence of drug resistant organisms [32]. Likewise, complications associated with prolonged recumbency are also avoided due to early mobilisation [33]. Two-stage revision arthroplasty using ALC but without long-term systemic antibiotic therapy has also been reported by Stockley et al [19] in a recent study of 114 patients treated for chronic THA infections. Infection was successfully eradicated in 100 patients (87.7%) at a mean follow-up of two years.

Spacers

Spacers are classified as static or non-articulating spacers, medullary dowels, and articulating or mobile spacers. Despite the superior elution properties of ALC beads [34], they are rarely advocated nowadays due to the associated limb shortening causing higher energy requirements for gait, loss of tissue planes, contracted soft tissues and scarring which results in difficulty identifying and removing them at the 2nd stage procedure [17,35].

a) *Static/nonarticulating spacers*

Static or simple block spacers allow local delivery of a high concentration of antibiotics and at the same time function to maintain joint space for future revision procedures. They facilitate surgical dissection

at the time of reimplantation and allow delivery of the antibiotics of choice according to sensitivities [23,36]. The disadvantage of a static spacer is that it does not allow physiological motion of the joint which results in periarticular scarring and muscle contractures adding to the morbidity and substantial impairment of patients' normal daily activities during the prolonged course of treatment. Another drawback of the static spacer is bone loss attributed to migration of the block spacer. On the other hand, static spacers have been associated with less generation of debris in comparison with mobile spacers [23,36].

b) Medullary dowels

A tapered cement dowel fashioned from the nozzle of a cement gun provides an excellent size and shape for a spacer to be inserted into the medullary canal during treatment of infected THA. A small bulb is left at the end of the dowel to prevent migration of the dowel down the femoral canal and help facilitate removal. After insertion, a moulded arthrodesis block or an articulating spacer may be inserted. Disadvantages include the potential for proximal femoral migration and the fact that these cannot be used in patients with severe femoral bone loss [23,36].

c) Mobile/articulating spacers such as the prosthesis of antibiotic-loaded acrylic cement (PROSTALAC)

The primary aim of this technique is to maintain function and soft tissue tension between stages to facilitate the second-stage reimplantation procedure. It has also been reported to reduce bone loss in comparison to static spacers [37]. Duncan and Beauchamp [38] first described the successful use of PROSTALAC for the 2-stage revision of infected THA. The cement of the femoral head articulated with the bone of the acetabular bed causing bone erosion and discomfort. An acetabular cement component was therefore introduced; preventing loss of acetabular bone with a theoretical advantage of higher antibiotic elution due to the continuous friction of the cement components and the emergence of new antibiotic-eluting surfaces. However, the cement-on-cement articulation limited motion and caused discomfort. The PROSTALAC system now consists of a constrained cemented acetabular component and a femoral component with a modular head that is made intra-operatively with ALC surrounding a stainless steel endoskeleton, using a series of molds. A sufficient degree of antibiotic elution from PROSTALAC has been measured for a period of over 4 months when at least 3.6 g of tobramycin per 40 gram of bone cement and 1 gram of vancomycin are used [18,39]. Whilst providing high doses of local antibiotic delivery, this system also allows

earlier mobilisation out of bed and accelerated rehabilitation and discharge from the hospital between stages of treatment avoiding the complications associated with prolonged hospital stay and immobilisation [40]. More recently, the option to use a preformed PROSTALAC equivalent with fixed low-dose antibiotic content has become available. Prefabricated molds of different sizes are also available, allowing the surgeon to select antibiotic dose and content. However, the disadvantages of preformed mobile spacers include limitation in implant sizes and antibiotic dose, often allowing delivery of only a single antibiotic to which the organisms being treated might not be susceptible [23,36]. Mobile spacers formed in the operating room have the advantage of adjustable antibiotic dosing. Disadvantages of such spacers include additional time to construct the implant in the operating room, the higher risk of fractures due to cement heterogeneity and inconsistencies in mixing and the potential risk of toxicity when high doses of antibiotics are added to the cement [23,36]. Various designs of articulating spacers have also been used including re-implantation of the excised prosthetic components after intraoperative sterilisation and specially designed reusable silicone or metal molds over metal endoskeletons such as rush pins and Kirschner wires with overall good results [41, 42].

After radical debridement, removal of all components and taking at least five tissue samples for bacteriologic and histologic assessments, the acetabular component is cemented loosely and femoral fixation is achieved by means of a press-fit or late proximal cementation so that both are removed easily at the second stage without damaging bone stock. Postoperatively, the patient is allowed to mobilise partial weight-bearing with crutches and is discharged home when deemed safe. Antibiotic therapy tailored to the sensitivities of intraoperative cultures is continued for 4 to 6 weeks. The decision to proceed with insertion of a new prosthesis is determined if the culture of a hip aspirate performed 4 weeks after discontinuation of antibiotics is negative and inflammatory markers suggest resolution of infection (ESR < 30mm/hr and CRP < 10mg/L). At the second stage, the spacer is removed without difficulty and the underlying cement mantle is fragmented and removed piecemeal, without sacrificing bone stock. Appropriate implants are then reimplanted with either cemented or cementless components, and allografts may be used in cases of severe bone loss [38]. After the reimplantation procedure, patients are followed clinically and with ESR and CRP levels for any signs of recurring infection. Systemic antibiotics are discontinued. However, if at the second stage there is clinical

evidence of ongoing infection, a repeat debridement procedure is performed with new culture specimens sent for microbiology and systemic antibiotics are adjusted accordingly. At this stage, either a repeat PROSTALAC insertion or a salvage procedure is considered after discussion of treatment options with the patient.

Conclusions

In conclusion, treatment of late chronic hip joint infections after THA is a challenging problem. The gold standard remains a two-stage revision arthroplasty using antibiotic-impregnated cement spacers which achieves an infection control rate over 90%. Articulating spacers provide the advantages of maintaining limb length and joint mobility, minimising soft-tissue contracture and scarring, and facilitating second-stage reimplantation and therefore, should be used as the first option of treatment for late chronic hip joint infections.

Conflict of interest

The authors have declared that no conflict of interest exists.

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