

Use of the Articulated Spacer in Managing an Infected Total Knee Arthroplasty

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Abstract

In modern Orthopaedics, the number of total knee replacements being performed continues to increase. As such, the absolute numbers of cases which become infected have also increased and hence, knowledge of the management of infected total joint replacements will continue to be of utmost importance. The choice of treatment depends on a variety of reasons including the chronicity of infection, virulence of the infecting organism and the host factors (e.g. age, health, immunologic compromise). The treatment goals aims to eradicate infection while preserving knee function and controlling pain. Surgical alternatives include arthrodesis, debridement and prosthesis retention, resection arthroplasty, single or two-stage exchange arthroplasty. In the majority of cases two-stage exchange arthroplasty remains the gold standard of care. An articulated spacer plays an important role in this procedure in making the second operation technically easier while simultaneously achieving quicker return to function.

Keywords: *Articulated; Spacer; Arthroplasty; Total knee; Infected*

Abbreviations

TKA: Total Knee Arthroplasty; ROM: Range of Motion; PWB: Partial Weight Bearing; PROSTALAC: Prosthesis of Antibiotic Loaded Acrylic Cement

Introduction

Total Knee Arthroplasty (TKA) is one of the most frequent prosthetic surgeries performed over the past few decades due to its success in restoring function in disabled arthritic patients [1]. It is recognised that one of the most devastating complications of TKA is deep infection [2] and the most effective treatment is prevention [3]. Extensive debridement, removal of all cement and components, insertion of an antibiotic impregnated cement spacer, a period of intravenous antibiotics followed by reimplantation of a new prosthesis remains the gold standard of treatment of an infected TKA. It has been argued that using an articulated spacer offers some advantages over the static spacer including but not limited to, improved range of motion, improved bone stock and increased patient satisfaction. The following article gives the evidence justifying its usage as an important aspect of undertaking two-stage exchange arthroplasty.

Discussion

An infected total knee arthroplasty (TKA) is a difficult challenge for an Orthopaedic surgeon [2,4,5]. It is one of the worst complications of TKA [6,7]. Challenges include necrotic soft tissues and bone, bone loss and subsequent difficulty in exposing the knee during reimplantation because of extensive scarring [4]. In modern Orthopaedics, the incidence rates of infected TKA's are 0.3 - 2% [8]. As the number of TKA's performed annually continue to increase, incidence of infection will increase also [9]. The rates vary because of a large number of patient factors [8]. Revision of an infected TKA is twice the cost of an aseptic revision and 3 - 4 times more expensive than the primary procedure [10].

The choice of treatment depends on several factors including chronicity of infection, virulence of the infecting organism and the host factors (e.g. age, health, immunologic compromise) [9]. The chronicity of the infection may be classified according to the Tsukayama clas-

sification where a late chronic infection is one in which the infection occurs later than one month after surgery [10]. The most common organism associated with superficial or deep infection is *Staphylococcus* [9]. Metallic components act as a nidus for infection and as this progresses, it invades the interface between host bones and cement or implant [9].

The treatment goals are eradication of infection while preserving knee function and controlling pain [2,9,12]. The surgeon affects the final outcome via the initial joint debridement, the protocol and type of spacer used between surgeries, the surgical technique, and selection of the prosthesis at reimplantation [12].

Surgical alternatives include arthrodesis, debridement and prosthesis retention [1], resection arthroplasty [2], single or two-stage exchange arthroplasty [1]. Unfortunately, there are no prospective trials comparing the different surgical options [1,13]. Indications for knee arthrodesis include poor quality of bone and soft tissues, highly resistant organisms, patients unsuitable for demanding reconstructive procedures and failure of exchange arthroplasty [1]. Debridement and prosthesis retention is indicated in early postoperative infection or late acute haematogenous staphylococcal or streptococcal infection up to two weeks after onset of symptoms, or in later cases where the prosthesis is functioning well [1]. Resection arthroplasty creates a false joint which allows some ROM, via removal of components. Three to six months is the time period given to allow the soft tissues to retract and to provide some stability [2]. Single stage exchange arthroplasty has a limited role and mainly applicable for hip prosthesis [1]. Single stage exposes the patient to the risk of remaining bacteria to reinfect the newly placed implants [1].

There is not a significant amount of literature on 1st stage revision [14]. It has been suggested that aggressive debridement, usage of antibiotic impregnated cement and three months of antibiotics are important factors that may allow similar results between 1st stage and 2nd stage procedures [8,15]. If successful, a single stage procedure would have the advantage of reduced morbidity. Despite this, the role of this operation is not well defined [13]. Advocates of 2nd stage reimplantation cite lower infection rates when compared to 1st stage revision but 1st stage may be successful in carefully selected patients [8].

Two-stage implantation was first advocated by Insall, *et al.* [16] for chronically infected TKA. Two-stage reimplantation is considered the gold standard in the treatment of infected TKA [5,7,13,17]. During the first surgery, prosthetic components and all of the cement are removed. Extensive debridement of synovial membrane, devitalised bone and periarticular tissues are also performed. The tissues are sent for histopathology and culture and sensitivity [18]. Prior to the first stage, the micro-organism should be cultured, if possible, so that culture directed therapy may commence [1]. Between stages, white cell count, erythrocyte sedimentation rate and C-reactive protein are obtained at routine intervals. These laboratory studies in conjunction with knee aspirations guides the timing of the 2nd stage [7], that is, the final implant is placed only when eradication of infection is confirmed [2]. Jansen, *et al.* [13] performed a literature review between 1980 and 2005, and stated that in all studies reviewed, intravenous antibiotic was given at least 4 - 6 weeks and continued until results of operative bacterial cultures were ready. After the first phase, one must be willing to remove the implanted spacer and to redebride the joint if there is elevation in the markers of inflammation or if the patient's symptoms persists [13]. A combination of antibiotics and lavage of retained implants has a limited role [14]. A comparison between short and long term antibiotics has not been studied [13]. Minimal medical comorbidities which allow the patient to tolerate more than one surgery and adequate bone stock are both required for two stage reimplantation [1]. Several of these patients are elderly with medical comorbidities and hence are poor surgical candidates [19]. There is potential significant morbidity in this population of patients because of prolonged immobilisation [1]. Historically, during the interval between stages, the options for managing knee instability were skeletal traction, external fixation or a plaster cast [20]. Villanueva-Martinez, *et al.* [6] found that the time between initial debridement and final reimplantation did not affect outcome once partial weight bearing (PWB) and controlled mobility occurred. Patients with bilateral infection may be offered debridement and prosthetic retention, however Wolfe, *et al.* [19] has noted uniformly poor results, including those who have acute infection. The patients in these cases should be counselled about likely poor function and most will have pain [19]. They [19] therefore recommended resection arthroplasty as definitive treatment in patients with minimal medical comorbidities.

Two-stage reimplantation is expensive and may result in large skeletal defects, long periods of hospitalisation, severe functional impairment and occasionally death [1]. Severe functional impairment includes impaired mobility, limited stability and pain may also occur [17]. It may be technically demanding because of scar formation, limb shortening, disuse osteoporosis and altered anatomy [9].

Without a spacer, stiffness and ligament contracture may cause significant problems with reimplantation [21]. There are different types of spacers currently used in chronic infected TKAs: Block spacers and articulated spacers. One type of articulated spacer uses antibiotic cement and preformed molds. Another type involves using metal and plastic coated with antibiotic impregnated cement [21]. Spacers have evolved from simple monoblock designs [18]. Many are hesitant to use a complex articular spacer either because of cost, or in other cases, the fear of inserting metal and plastic in a septic joint [18]. Haddad, *et al.* [17] however reported a 91% infection eradication rate using the Prosthesis of Antibiotic Loaded Acrylic Cement (PROSTALAC) which has metal and polyethylene components. It is made primarily of gentamicin-loaded Palacos[®] bone cement with a femoral and tibial component [22]. Wam, *et al.* [22] found that PROSTALAC allowed maintenance of ROM resulting in a faster, uneventful 2nd stage and a better quality of life.

Early series reported encouraging success rates with static antibiotic cement block spacers. They delivered a high dose of local concentration of antibiotics compared with intravenous administration [21]. Despite widespread clinical use, there are lack of guidelines for antibiotic dosage and mixing methods [8]. Spacers are considered clinically safe; however renal function must be monitored postoperatively, especially when using intravenous agents such as gentamicin and vancomycin [7].

Despite good eradication rates, reimplantation has been challenging because of contracted soft tissues and poor bone stock which led to frequent complications e.g. limited ROM, contracted quadriceps or abductor shortening [4,5,7,21]. Hsu, *et al.* [5] found that 37.5% of his patients required a V-Y Quadricepsplasty for surgical exposure during the second stage procedure, after using a static antibiotic impregnated cement spacer. Hsu, *et al.* [5] noted that bone loss was common in cases where the spacer blocks were made without a small intramedullary stem and they were undersized.

Articulating spacers was subsequently introduced to maintain ROM between the two stages and to enhance functional status [17,23,24,25]. Poor ROM, joint stiffness, and difficult exposure at reimplantation motivated the development of articulated spacers [21].

Use of an articulating spacer minimises disuse osteoporosis, minimises bone loss, supports wound healing and promotes easier rehabilitation in efficient surgical time [7,21,26]. The articulating spacer allows easier exposure during the 2nd stage and thus eliminating the need for tibial tubercle osteotomies or quadricepsplasties [21,24] and promotes a healthy supple periarticular soft tissue sleeve [21].

Compared to static spacers, the use of articulating spacers doesn't reduce eradication rates, but does enhance function [17,24,26]. The recurrence rates of infection for resterilised prosthesis spacers and articulating polymethylmethacrylate spacers were 0-6% and 0-7% respectively [13]. Jansen, *et al.* [25] noted that resterilised spacers were found to give better functional scores without reducing eradication rates [25]. He found that two patients using the resterilised prosthesis were so satisfied with their function, they refused surgery. Su, *et al.* [24] stated that although most of his patients with articulating spacers felt satisfied with their function, long term retention of spacers was not recommended because of the possibility of bacterial recolonisation after antibiotics were exhausted. Jansen, *et al.* [25] concluded that the ability to mold a spacer allows perfect matching with residual bone thus limiting need for gap filling due to reduced bone loss. Consequently, postoperative ROM is maintained due to preservation of collateral ligaments and the patellar tendon [25].

Hofmann, *et al.* [21] used high-dose antibiotic impregnated polymethylmethacrylate bone cement in an articulating spacer in 50 patients during the first stage of a two-staged procedure. The spacer was created utilising an autoclaved femoral component and the polyethylene insert. The cement was applied to the components early and applied late to the bone to allow molding to any defects without interdigitation and adherence. Hofmann, *et al.* [21] had a 90% infection eradication rate. Emerson, *et al.* [26] reported similar eradication rates of infection whether using a static or articulated spacer (92% vs. 92%), but also reported that the average ROM was 14° greater in the articulated spacer. The autoclaved femoral component and the polyethylene insert provide a smooth gliding surface [24]. The final implant is placed only when eradication of infection is confirmed, e.g. via repeat culture from aspirations [2].

Arthroscopic debridement and lavage is an option to open surgery where there is reduced trauma to the joint and soft tissues, however the posterior knee cannot be adequately debrided since the polyethylene liner is retained [9]. Jamsen, *et al.* [13] found in his literature review that the major advantage of articulated spacers versus static spacers is the improved range of motion. Post reimplantation, Lombardi, *et al.* [3] found that in 51 patients, the average ROM at five months was 101°.

Handmade spacers are the most commonly used spacers [6]. Villanueva-Martinez, *et al.* [6] found that handmade spacers function just as well as more complex, more expensive constructs. They allow the patient to partially weight bear between stages, minimised retraction of the extensor mechanism, prevented muscle atrophy, reduce pain, preserve bone stock and allowed an average ROM of 80° [6]. These spacers are made without autoclaving any components or using plastic trials or metallic components [6]. Potential pitfalls in making these spacers include excessive soft tissue tension, femoral component instability due to lack of a posterior capsule release and anterior subluxation secondary to elevation of the posterior part of the tibial component [6]. Su, *et al.* [24] developed a low cost articulating spacer comprising of cement on cement articulation by using an impression taking technique with polydimethylsiloxane. There were no reports from the cement on cement surface of the spacers, of particle related complications. He performed gap tensioning intraoperatively and noted that subsequently there was no need for extensive scar release. He also found reimplantation to be easier than revision for an aseptic joint, which involved removal of well fixed components.

Temporary articulating components with antibiotic impregnated cement implanted during the first phase of two-stage reimplantation have proven to be a valuable aspect of the treatment of an infected TKA. It allows knee motion and partial weight bearing which promote healthy and supple periarticular soft tissues. It also facilitates ease of exposure during the second stage and allows a functional joint [3].

Conclusion

The majority of reports on exchange arthroplasty for infected TKA are of poor methodological quality. There is a lack of unbiased comparative studies. Factors which reliably predict outcome are unknown, and hence two-stage arthroplasty remains the gold standard. Satisfactory outcomes have been reported with the usage of the different types of spacers; however, the articulated spacer appears to offer superior ROM.

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Conflict of Interest

Nil.

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