



Treatment of Prosthetic Joint Infection Following Total Knee Arthroplasty: Current Review

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Abstract

Periprosthetic Joint Infection (PJI) is a devastating complication following Total Knee Arthroplasty (TKA). Its management poses a great challenge and success rate remains highly variable. This has led to considerable variations in alternative surgical treatments. So in this review, we will discuss various surgical treatment options for PJI following TKA, pros and cons of each method and ultimate outcome measures.

Keywords: Prosthetic joint infection; Total knee arthroplasty; Irrigation and debridement; Single stage revision; Two stage revision

Introduction

Number of Total Knee Arthroplasty (TKA) is increasing worldwide and number of complications necessitating revision is also increasing [1,2]. Prosthetic Joint Infection (PJI) following TKA is devastating complication. Most studies report an infection rate of 1% to 2% following TKA [3]. Infection is financial and social trauma to both patient and health care system [4]. And to manage the infection following TKA is one of the biggest challenges to solve. Proper management of PJI is of critical importance, as infections may lead to compromised outcomes associated with considerable morbidity and economic burden.

Currently, many treatment modalities exist for the treatment of PJI following TKA including Incision and Drainage (I & D) with or without modular insert exchange, single and 2-stage revision, all of which have specific risks and benefits to the patient [5]. Revision TKA in the setting of infection is particularly challenging and requires the orthopedic surgeon and patient to evaluate treatment objectives, as well as risks and benefits associated with each treatment modality. Persistent debate is still going on regarding ideal treatment strategy for PJI. Different consensus and philosophy is there in different part of world. Which one to follow is the biggest question? So our aim is to describe pros and cons of each ideology and to discuss recent and current concepts regarding treatment of prosthetic joint infection after total knee arthroplasty.

Irrigation and Debridement

Irrigation and Debridement (I & D) with or without exchange of modular part is more conservative and traditional treatment of choice for an acute post-operative and acute hematogenous infection minimizing the morbidity [6]. In early stage with acute infection, bacteria have not yet formed an impenetrable glycocalyx biofilm layer along the prosthetic components. Theoretically then, by undertaking I & D, one could diminish the bacterial load in the joint and retain fixed implants, thereby minimizing patient morbidity [7]. Depending on timing of infection symptoms, pathogenicity of infecting organism, and immune status of infected patient, I & D may or may not in fact be initial procedure of choice for all acute PJI.

The role of symptom onset relative to the index joint procedure has been studied with regards to the success of I & D in treating PJI. Reports by Narayanan et al., [8] and other authors have concluded that the duration of I & D within 2 weeks of primary TKA has favorable outcome in infection eradication rate. On the other hand, Koyonos et al., [9] showed that when comparing outcomes after I & D, acute postoperative (<4 weeks), acute delayed (acute onset symptoms >4 weeks from index surgery), and chronic PJI all showed relatively equal rates of infection eradication [9]. With regards to infecting organism, there is much controversy surrounding the role of organism virulence and antimicrobial resistance profiles on failure of I & D procedures. Some authors have concluded

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that staphylococcal infection lead to relatively low success rates after I & D [10]. Furthermore, infections with methicillin resistant staphylococci have been shown to lead to even lower success rates [11]. While in study by Zhang et al., [12], most common organism was staphylococcus and it had no effect on outcome of I & D. Main reason behind failure in case of staphylococcus is it is more likely to form biofilm [13].

Debridement without exchange had zero success rates [12]. Many reports strongly recommended inserts must be exchanged during surgery [14,15] unless and until not possible to be exchanged. Polyethylene insert exchange allows the surgeon to get better access to the posterior joint capsule and bilateral gutters for radical debridement. Along with the biofilm adhered to the insert, removing it would reduce the bio-burden of infection. Surgeons would also have the chance to clean the tibial component once the insert is removed. So there is universal consensus regarding exchange of polyethylene liner is must. General comorbidities of the patient with PJI may affect the outcome after I & D. Literature supports that patients will have compromised wound healing secondary to medical conditions including rheumatoid arthritis, diabetes mellitus, and chronic renal failure [16,17]. On the contrary, a small study by Odum et al., [18] did not find significance with different American Society of Anesthesia (ASA) scores [18]. Special care must be taken in medically optimizing the patients before going for the surgery. In case of I & D sometimes it is not possible to optimize severely compromised patients, in those cases it would be better to take strong decision and directly go for two stage revision surgery [8].

Various literatures have variable success rate with variable affecting factors regarding success of I & D [12]. Previous studies have success rates up to 70% while on the other hand, some studies failure rate as high as 80% [9,19]. Though variable outcomes, I & D with insert exchange does have positive role in management of acute PJI, while debatable role in case of chronic PJI [9]. Main advantage being it offers more palatable option for the patient with promising rate of success while being less expensive and successful trial before going for 2 stage revision surgery. Due to its easy and efficient procedural technique, I & D will always remain an appealing option for treating PJI.

One stage revision

While two-stage exchange arthroplasty is treatment of choice for PJI in the United States, many European centers have long advocated the use of a single stage procedure [20]. Main concern for single stage revision is less morbidity, lowered cost and improved functional outcome but on the risk of reasonable chance of reinfection. Single stage revision for infection in TKA involves removal of the implant followed by debridement and immediate reimplantation of a new prosthesis, usually with antibiotic loaded cement. Overall attraction for single stage revision is increasing popularity worldwide because of less financial burden with decrease in morbidity. But common agreement from all published literature suggests specific criteria for selection of patients for single stage revision. [20]. Various literatures have varying success rate from 73% to 100% for single stage revision with different surgical criteria and patient selection [5,21]. Overall outcomes in single stage exchange arthroplasty have been improving over the years. In a review of eight studies with 37 patients undergoing single stage exchange for PJI of the knee, Silva et al., [17] found an 89% infection eradication rate. They reported negative predictors to be frequently associated with type of infecting organism with

polymicrobial, gram negative and methicillin- resistant organisms yielding the worst outcomes.

Other studies reported improvement in Knee Society scores after a single-stage revision for PJI. Singer et al., [22] reported a mean Knee Society score of 72 points after 24 months and a mean reported range of movement of 104°. Buechel et al., [23] also had a similar mean final postoperative knee score of 79.5 (range, 35 to 94). This may support an easier convalescence as a potential advantage of a single-stage procedure. Though attractive success rate and improved functional outcome, single stage revision warrants the strict selection and exclusion criteria. Recommendations during surgery are as followed.

- Healthy soft tissue coverage surrounding prosthesis is must.
- Preoperative identification of infecting organism with its sensitivity to specific antibiotic.
- Peroperative thorough debridement, extensive synovectomy and implant removal, wash with normal saline and povidone iodine.
- Rescrub, redrape and different set of instruments for implantation. And use of antibiotic cement.
- Start immediate antibiotic as per the preoperative microbiological report and titrate the dose and molecule as per the final culture report.

• Early mobilization to get the good functional outcome.

Exclusion criteria for patients not fit for one stage revision surgery

- Significant soft tissue compromise and bone loss
- Preoperative Unidentified organism, culture negative infection
- Polymicrobial infection
- Multiresistant MRSA
- Immunocompromised host
- Systemic sepsis
- Multiple reinfections

Two stage revision

Two stage revisions are a gold standard procedure and preference of choice for PJI since decades [24]. The first stage involves complete resection of all foreign material, debridement of surrounding infected soft tissues, and placement of an antibiotic impregnated cement spacer. The second stage involves removal of the spacer and any additional necrotic tissues, thorough irrigation, and placement of new prosthetic implants. Acute infection in immunocompromised hosts with high virulence-resistant organisms such as Methicillin-Resistant Staphylococcus Aureus (MRSA) may best be treated with initial two-stage exchange [25]. Furthermore, in cases of acute PJI where an initial attempt at more conservative surgical treatment such as I & D or one-stage exchange have failed, use of subsequent two-stage exchange procedures have been indicated [26].

Main reason why it is considered gold standard is that the procedure is done with intra-articular antibiotic loaded cement spacer. So the local elution of antibiotic is in very high concentration as compared to minimum inhibitory concentration of bacteria, so even if the bacteria are resistant to antibiotic, it will kill the infective

organism. It will allow the tissue to heal in absent of implant. And another advantage of spacer is it will prevent soft tissue contracture. Overall, infection eradication using two-stage exchange is quite high, ranging from 85% to 100%, and does not depend on the type of antibiotic loaded cement spacer used [20]. Major concern of PJI is eradication of infection which is taken cared by antibiotic loaded cement spacer. Another issue is for timing for removal of spacer and reimplantation. Average time described in the literature is 6 weeks to 8 weeks [27,28]. After that period there will not be any release of antibiotic so spacer will act as a foreign body and may increase the chances of infection. Aspiration of the joint fluid and rule out the infection is advisable before proceeding of 2nd stage revision. And if per-operative unhealthy tissues are found, reimplantation is to be delayed and reinsertion of cement spacer is performed. Eradication of the infection is of prime importance.

Main drawback of 2 stage revision is that the interval between stages is often associated with impaired mobility, joint stiffness and pain. Development of arthrofibrosis can make reimplantation difficult [5]. So to avoid this some prefer articulating spacers over fixed block [29]. Articulating spacer will help moving the joint and prevent stiffness after 1st stage. But in some cases where soft tissue is severely compromised, articulating spacer will prevent healing so in such cases spacer block is required [30]. While certain situations such as extensive bone loss prohibit the use of articulating spacers, debate remains as to the optimal choice [30]. Main purpose to advocate the use of articulating spacers is to minimise stiffness and scar formation. Haddad et al., [31] reported a series of 45 patients with a 91% success rate using such a technique [31]. Again in some cases of cement spacer, 2nd surgery may become difficult.

Patient satisfaction and joint functionality are improved as well particularly in knee arthroplasty, with Meek et al., [20] showing good WOMAC pain and functional scores after revision at the same time two-stage surgery obviously involves two major procedures with the associated cost and sometimes a prolonged length of hospital stay.

Conclusion

With increasing rate of PJI following TKA, ideal management for PJI is a burning issue. Debridement with prostheses retention has a moderate success rate for acute PJI but still more palatable option for the patient with promising rate of success while being less expensive and successful trial before going for two stage revision surgery. Two stage revision TKA procedure though it is considered the gold standard for the management of infected TKA, yet not without complications. Good number of literature supports the use of single stage revision surgery in infected TKA cases as an alternative to a two stage procedure, in carefully selected patients.

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