The Journal of Arthroplasty 30 (2015) 912–918

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Surgical Treatment of Prosthetic Joint Infections of the Hip and Knee: Changing Paradigms?

William A. Jiranek, MD, Andrew C. Waligora, MD, Shane R. Hess, DO, Gregory L. Golladay, MD

Department of Orthopaedic Surgery, VCU School of Medicine, Richmond, Virginia

ARTICLE INFO

Article history:
Received 6 January 2015
Accepted 13 March 2015

Keywords:
periprosthetic infection
revision knee arthroplasty
revision hip arthroplasty
irrigation and debridement
antibiotic spacers

ABSTRACT

Prosthetic joint infection (PJI) of the hip and knee remains one of the most common and feared arthroplasty complications. The impact and cost of PJI is significant, both to the patient and to the health care system. Recent reports of results of different treatment strategies have led many surgeons to modify their approach to management of PJI. This paper will explore apparent paradigm shifts, both to indications and technique, including the importance of waiting for bacterial identification, the decreasing role for irrigation and debridement (I&D) with retention of components, the increased utilization of single stage revision, and conversely a decreasing role for two-stage exchange. Strategies for treating drug-resistant organisms and management of failed treatment will also be examined.

Options for Treatment of PJI

Successful treatment outcomes require precise assessment of the infecting organism, the immune status of the patient, and the condition of the bone and soft tissues around the joint [1]. This has led to a more deliberate assessment prior to operative treatment, as it is felt that this assessment is more important than a rapid trip to the operating room where a "conservative" treatment may be inadequate and subject the patient to the morbidity of multiple additional procedures, with perhaps decreased success of more definitive procedures [2].

Confirming Diagnosis and Stratifying Individual Patient Risk

Numerous studies have demonstrated the importance of identifying the infecting organism in PJI, and determining its antibiotic sensitivities, prior to any surgical treatment [3–5]. While Staph species grow relatively fast on culture media, many other infecting organisms do not, and additional inoculation time and special techniques outlined in the proceeding diagnosis paper are warranted. The determination of methicillin or other antibiotic resistance is critical in selecting the appropriate treatment, as virtually all studies have shown poor results for both irrigation and debridement (I&D), and one-stage revision, for antibiotic resistant PJI, even in patients with early PJI. There has been much recent work on using host biomarkers to improve diagnostic accuracy for PJI which may increase the accuracy and decrease the time for bacterial characterization [6,7].

In addition, numerous studies have identified patient risk factors that have compromised the results of I&D and single stage revision for PJI. Diagnosis of diabetes, renal failure, immunosuppression due to inflammatory conditions, HIV, or transplantation, and prior prosthetic infection should point the surgeon away from these treatment options.

Role of Irrigation and Debridement

I&D with retention of the implants involves excision of devitalized bone and soft tissue, drainage of purulent material and hematomas, and removal of any draining sinus tracts. Traditionally, this method was recommended for postoperative infections within three months of the procedure or acute hematogenous infections. In both scenarios, patients needed to have stable implants, a healthy soft tissue envelope, and the presence of symptoms for less than three weeks [8]. Irrigation and debridement was thought to be successful for these infections because the bacteria had not yet developed a glycocalyx biofilm over the implants [8]. Therefore, a thorough debridement would be able to reduce the bacterial load without significant morbidity.

An outline for I&D has been provided by an international consensus workgroup [9]. There was a 90% consensus for the following components of the surgical technique:

(1) Preoperative optimization of the patient.
(2) Good visualization and thorough debridement.
(3) Obtaining multiple culture samples.
(4) Copious irrigation (6–9 L) of the joint.
(5) Explantation of the prosthesis if indicated.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2015.03.014.

Reprint requests: William Jiranek, MD, Department of Orthopaedic Surgery, VCU School of Medicine, 9000 Stony Point Parkway, Richmond, VA 23235.

http://dx.doi.org/10.1016/j.arth.2015.03.014
0883-5403/

At our institution, I&Ds of knee prostheses are performed without a tourniquet. Preoperative antibiotics are always given prior to incision. We begin every I&D by performing an excision of the previous incision site. Full-thickness deep tissue flaps are created to allow for adequate visualization. Prior to the arthrotomy, synovial fluid is aspirated and sent for cell count, differential, and culture. Once the arthrotomy is completed, we perform a thorough synovectomy as a part of both the debridement and the exposure. The excised synovium is also sent for culture. Modular components are removed to allow for a thorough debridement of all interfaces and to obtain improved exposure of those areas that are difficult access (for example, the posterior capsule of the knee). A total of three to six cultures are sent from the synovium and periprosthetic tissues. Once all fibrinous, devitalized, and suspicious tissue is excised, the entire surgical wound is mechanically debrided with a sterile scrub brush while soaking in 500 mL of a dilute betadine solution for approximately three minutes. The entire wound is then irrigated with 6 L of sterile normal saline solution. The surgical site is re-evaluated for any evidence of suspicious tissue or remnants of braided suture. Once the wound is judged to have been thoroughly debrided, the arthrotomy and skin are provisionally closed with monofilament suture. The entire surgical field is broken down, all of the opened trays are removed, the floors are thoroughly mopped, and all members of the surgical team change their scrubs. The operative extremity is then repreped and redraped. The incision site and arthrotomy monofilament sutures are removed, and the surgical site is irrigated with a final 3 L of saline. The previous modular components are then replaced with new implants. The arthrotomy, deep tissues, and incision site are closed in layers with monofilament sutures.

The absolute contraindication to I&D with retention of implants is the inability to close a wound. Soft tissue defects create an ideal environment for persistent contamination which can result in chronic colonization [9]. Additionally, these scenarios are also more likely to have a polymicrobial infection [10]. Relative contraindications to irrigation and debridement include highly virulent organisms, presence of a polymicrobial infection, immunocompromised host status, and the presence of a draining sinus tract [3].

There is increasing evidence of the substantial morbidity and cost of I&D as a treatment for prosthetic joint infection. Many centers report poor results when this treatment is utilized [11–13]. While most studies demonstrate a success rate of between 40% and 50% [13–17], some have published successful outcomes in as few as 10–20% of their patients [11,18,19]. Furthermore, there is concern for an increased risk of failure in two stage techniques after an initial failed I&D. While there is no literature that describes outcomes of two stage procedures after a failed I&D in total hip arthroplasty, there are two studies that provide pessimistic results in total knee arthroplasty. One study reported that 34% of their patients who had undergone a two stage exchange after a failed I&D required subsequent procedures for persistent infection [20]. Another group reported a 42% failure rate for two stage procedures following a failed I&D [17].

Several factors may be responsible for these failure rates. One factor is the high level of drug resistant bacteria that are isolated from patients with confirmed prosthetic joint infection treated with I&D [21,22]. In a series of 112 patients treated between 1998 and 2003, 44% grew Coagulase Negative Staph species — 60% of these species were resistant to methicillin. Additionally, 8% of the isolates were positive for MRSA. Altogether, over 30% of the cases in this series were resistant to methicillin [23]. Infections with resistant bacteria have been historically more difficult to treat [24,4,25,26,5,22]. Bradbury et al found a failure rate of 82% when patients with acute periprosthetic MRSA infections were treated with I&D [4].

There is evidence that between 14% and 39% of prosthetic joint infections are polymicrobial [10,17,27]. Polymicrobial prosthetic joint infection treatment has a high failure rate when treated with I&D alone [10,27,5], showing relatively consistent success rates of 53% compared with 78% for two stage procedures in some series [10]. In addition to the virulence of two different pathogens, some data has demonstrated that polymicrobial infections have higher rates of MRSA and anaerobic bacteria when compared to prosthetic joint infections with a single pathogen [10].

The second area contributing to failure of I&D may include host comorbidities. Many comorbidities compromise the immune system, limiting the host response to the infecting organisms. Choong et al found patients with a BMI of greater than 30, more than two comorbidities, and diabetes as independent risk factors for failure [28]. Other studies have shown an increased failure rate in those who carry a diagnosis of rheumatoid arthritis [29], are immunosuppressed [30], and have a history of previous infection within the same joint [31,32]. Additionally, patients over the age of 65 have been found to be at an increased risk for polymicrobial infections [10], which, as previously described, are more difficult to eradicate. Despite these findings, some studies have found no difference in their patient characteristics (including BMI, age, ASA score, inflammatory arthropathy, diabetes, malignancy, or heart disease) and the success of this procedure [14,32,17]. Despite the inconsistency in the literature, the consensus from Proceedings of the International Consensus on Periprosthetic Joint Infection workgroup is that patients receive optimization of all preoperative comorbid conditions prior to undergoing any surgical intervention for a PJI [9].

A third factor implicated in poor results of I&D is the chronicity of symptoms prior to surgical intervention [14,18,15,10,32]. Despite the large amount of literature describing the importance of the duration of symptoms, discrepancies remain with regard to the threshold for optimal outcomes. Studies have demonstrated the ideal timing to be within 8 days, 2 weeks, 3 weeks, or 4 weeks [32,14,18,10,15,27]. Despite these conflicts, the international workgroup decided to use the threshold described by Zimmerli et al of three weeks from the onset of symptoms 3]. Furthermore, this workgroup advocates addressing all preoperative comorbidities and complications, and the use of acute surgical intervention only in cases where patients demonstrate signs of septicemia [9].

Although there is literature describing the importance of symptom duration, there is conflicting data when comparing outcomes based on the interval between arthroplasty and the development of infection [32,15,33,14]. Confounding these results is the fact that many infections are indolent. Not all patients report longstanding symptoms prior to their presentation with a chronic infection. In fact, systemic symptoms are often subtle or absent. The identification of infection in what may appear to be acute cases may simply be a manifestation of the accumulation of a critical bioburden that has rendered the patient acutely ill. This means that the time course of infection can be difficult to pinpoint, as few PJI cases have a defined inciting event.

Another factor which may contribute to the poor results of I&D is the historical lack of uniform consensus on the details of appropriate surgical technique. Poor or incomplete surgical technique during I&D may leave behind significant bacterial burden or biofilm. The importance of adequate debridement has been noted by the EndoKlinik group [34]. Even with the consensus that a thorough debridement is imperative, numerous techniques have been described, even within the same study [17]. Surgical procedures have included methods for mechanical disruption (scrubbing and/or lavage), chemical disruption (dilute betadine, chlorhexidine washes, Dakin's solution), and isolation of contaminated surgical equipment.

Even with multiple variables, the international workgroup has been able to determine that there is no role for arthroscopic washout in an established PJI [9]. Data has demonstrated that arthroscopic I&Ds are significantly less successful than open debridement (47% and 88%, respectively) [31], likely because of the limited ability to access all of the interfaces [9].

The international workgroup advocates for the exchange of modular components despite only a small amount of literature demonstrating improved outcomes [35,30]. They believe that the removal of modular