

HK49: What is the optimal treatment for acute postoperative periprosthetic joint infection for patients who have received uncemented implants?

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Response/Recommendation:

In the absence of definitive evidence, we recommend that in patients with acute postoperative periprosthetic joint infection (PJI), a strong consideration be given to the removal of infected uncemented implants, particularly when not osseointegrated, and performing a one-stage exchange arthroplasty.

Level of Evidence: Limited

Delegate Vote:

Rationale:

The recommended surgical treatment of acute postoperative PJI has traditionally been a DAIR with or without modular component exchange. The success of this approach has been quoted in the literature to be approximately 70%. The failure can be potentially attributed to the existence of biofilm, and therefore other treatment options have been considered and explored, including multiple DAIR and one-stage exchange revision. The scenario of an acute postoperative PJI involving cementless implants poses a conundrum since sufficient time may not have passed to allow for solid osseointegration within the first four to six weeks after implantation. Therefore, some surgeons rationalize explanting all components and performing a one-stage revision to allow more aggressive debridement of the bony interfaces and remove all potential biofilm-covered implants without incurring the morbidity of removing well-fixed implants at a later stage if DAIR fails.

Historically, since most primary total hips implanted are cementless and most primary total knees are cemented, the majority of the data focuses on acute postoperative PJI of primary THA. However, cementless TKA and revision cementless THA will also be reviewed.

There are many limitations in the current literature on the optimal treatment of acute postoperative PJI in cementless implants:

- Historic definitions of an early or acute PJI utilized a 3-month post-operative threshold. However, the majority of the recent literature on acute, postoperative PJI now utilizes a cut-off limit of two to six weeks. This will unquestionably have a pivotal role in interpreting the existing literature, which has been published over a long period of time with an evolving understanding of the necessity of thorough surgical debridement to remove biofilm. This review has utilized a pragmatic approach, and the definition of acute PJI has been adopted by the individual authors unless otherwise specified.

- Furthermore, the acuity has serious clinical implications on the likelihood of osseointegration of cementless implants and progression of biofilm formation.
- Many studies combined acute postoperative and acute hematogenous PJIs in the treatment of the ‘acute PJI,’ and therefore results are often merged without stratification. The delegates performed sub-analyses of cohorts when the details were available.

There is tremendous heterogeneity in terms of protocols and treatment strategies, including but not limited to modular component exchange, use of antiseptic solutions, local antibiotics, and postoperative antibiotic courses. This confounds the overall success rates of each treatment strategy.

DAIR

Historically, the recommended surgical treatment of acute postoperative PJI following total joint arthroplasty has been a DAIR Spell out first time use abbreviations, and as a result, the vast majority of the literature on this topic has focused on this strategy. There is a wide variability in the reported success of DAIR for acute postoperative PJI, ranging from 55.5 to 90% across many studies and settings with an average of 71% (Longo, 2024).Number all references in text –Take out these names and years Multiple prognostic factors have been identified that may impact the success of this procedure, including joint affected (Ashkenazi, 2024), exchange of modular components (Gavaskar, 2024), acuity of infection (Ghnaimat, 2021), preoperative infectious laboratory values (Kuiper, 2013; Ashkenazi, 2024), patient comorbidities (Ashkenazi), gender (Choont, 2022), organism type and resistance profile (Walkay, 2022), dual surgical set up (Katakam, 2020), local antibiotic use (Indelli, 2023; Miyake, 2023; Whiteside, 2017), and postoperative antibiotic courses (Puhto, 2012; Nandi 2023; Malahias, 2020).

Modular component exchange provides greater access to irrigate and debride the whole joint and implant surfaces that may harbor biofilm. In a systematic review on the topic, Gerritsen et al. reported the success rate for hip DAIRs increased by 2.6% for each 10% increase in component exchange, but no significant difference in reinfection rates when restricted to more modern studies after 2004. (Gerritsen, 2021)

Most studies report earlier DAIR after index arthroplasty provides improved outcomes, though that threshold is not well defined in the literature: one week or less (Gupta, 2024; Ghnaimat 2021), < 45 days (Gavaskar, 2024), < six weeks (Tarity, 2021), < three months (Wouthuyzen-Bakker, 2020).

Significantly elevated pre-operative inflammatory labs, likely reflecting a more virulent organism and aggressive infection, have been associated with a higher failure rate after DAIR for acute postoperative PJI: ESR > 60 (Kuiper, 2013), CRP > 200 (Walkay, 2022), synovial WBC > 5,168/mL and PMN% > 88.5 (Ashkenazi, 2024).

Host factors also play a major role in a patient’s ability to clear an infection, especially as it relates to systemic inflammation and immunosuppression leading to failure of DAIR: elevated BMI (> 35, Walkay 2022), rheumatoid arthritis (Kuiper, 2013), increased CCI (odds ratio (OR) 1.57) (Ashkenazi, 2024), ASA spell out> 2 (Walkay, 2022).

There is one systematic review that has evaluated the impact of sex on outcomes of PJI after DAIR and found that the odds of treatment failure were 29% lower in women after adjusting for duration of symptoms > seven days and *S. aureus* infection, though the authors note that none of the 64 studies included in the paper conducted sex-specific analyses (Choong, 2022)

Local antibiotic adjuncts have demonstrated promising results in the setting of PJI treatment: antibiotic-loaded hydrogel (DAC- Defensive Antibacterial Coating) (Zagra, Int Orthop 2019; Pellegrini 2022); antibiotic-impregnated cement and cancellous allograft bone (Dersch, 2022; Winkler JBJS Br 2008); intra-articular infusion (Miyake, 2023); intraosseous antibiotics (Kildow, 2021).

Most studies support a minimum of a 6-week course of parenteral antibiotics following DAIR procedures. There has been a trend towards shortened courses without affecting results (Puhto, 2012). The addition of rifampin to the regimen for *Staphylococcus* infections has strong support because of its unique mechanism of action against biofilm (Tai, 2022). Oral suppressive antibiotics of varying durations are often initiated following completion of the intravenous (IV) course, though the length of treatment differs. One multicenter study suggested that the optimal duration is two years and does not induce resistance (Nandi, 2023). However, these suppressive antimicrobials are not benign, with at least one systematic review demonstrating a mean adverse effect of 15 and a 4% rate of adverse events leading to discontinuation (Malahias, 2020)

Multiple DAIR

The planned “Double DAIR” for acute postoperative PJI, popularized by the Mayo Arizona group, in which an initial DAIR (without component exchange) using antibiotic beads is followed five days later by a second DAIR (with modular component exchange), has reported infection control rates of 94 to 100% in primary THA and 72% in revision THA (Chung, 2019, Estes 2010). Unplanned second DAIR operations may also have some utility in preventing exchange arthroplasty. In a retrospective, multicenter study of mostly (129 of 144) acute postoperative PJI with the majority being hips (105 of 129), only 16% of cases needed to have components ultimately removed (Wouthuyzen-Bakker, 2020). A systematic review and meta-analysis comparing the outcomes of single versus multiple DAIR for early PJI included nine observational studies with 1,104 patients and included both hips and knees, finding that the success rate of the two approaches was similar (67 and 70%, $P = 0.7$) (Salman, 2024). Since it was not possible to separately analyze the hip versus knee results of this study, the regression to the mean due to the often inferior results of infected knees may have blunted the true benefit of multiple DAIR procedures for the acutely infected total hip subgroup.

One-Stage Exchange

The one-stage exchange arthroplasty, initially described by Bucholz et al., relied on preoperative identification of the infecting bacteria and using microbe-directed antibiotic-cemented revision components. Since that time, the technique has undergone iterative improvements and expanded indications over the past decades. In an acute postoperative infection of cementless implants that have not achieved osseointegration, the one-stage exchange arthroplasty allows for the removal of all biofilm-covered components, more thorough debridement of all bony interfaces, and the potential of improved infection-free survivorship. Riemer et al. published on a series of 18 patients who have acute postoperative (< six weeks) PJI after primary THA using this CORIHA

(Cementless One Stage Revision of Infected Hip Arthroplasty) technique with all patients retaining their implants at a minimum of 3-year follow-up and only two further surgeries for superficial I and D (Riemer, JBJS Infect 2022). A separate multicenter study including 27 similar patients reported that 19 (70%) were able to retain their implants at a mean of 50-month follow-up, with only four requiring further operative debridement with modular component retention (Hansen, CORR 2013).

Cementless TKA

In recent years there has been a rapid adoption of cementless total knees (Forlenza, 2024; Chiou 2023). Similar to a primary total hip, an acutely infected cementless total knee prior to bony fixation could be treated with DAIR or a one-stage exchange arthroplasty. However, there have been no publications to date on this particular topic. If extrapolating data from acute hip PJI, a DAIR may also be reasonable if the cementless TKA has achieved osseous ingrowth at the time of surgery or if the host, organism, and/or infection acuity are favorable. A one-stage exchange arthroplasty with antibiotic-loaded bone cement could be considered if able to be performed with minimal iatrogenic bone loss during explant with the added benefit of local antibiotic delivery.

Revision Arthroplasty

Revision hip arthroplasty carries a much higher risk of infection than primary THA, and most revision constructs are cementless because of the documented improved survivorship compared to their cemented counterparts. However, very little is written about the treatment of the acutely infected revision total hip. (Veerman, 2022; Chung, 2019). One study provided the outcome of DAIR for 88 early postoperative (< 90 days) infected arthroplasties, of which 53 were revision THA. They found that 72% of their infected revision total hips were successfully treated at a minimum of two years follow-up (Veerman 2022). Utilizing a double DAIR technique, Chung et al reported a similar success rate in 13 of 18 patients in their revision hip cohort. It is noteworthy that 56% of these patients were on suppressive antibiotics at the last follow-up (Chung 2019).

Conclusion:

The acute postoperative PJI in a patient who has cementless implants presents a conundrum for the treating surgeon. A one-stage exchange arthroplasty represents an attractive option in order to remove any potentially biofilm-covered implants and allow for a more aggressive surgical debridement. Thorough debridement of all necrotic and infected tissues is a critical component of surgical procedures for these patients. It is technically easier and less morbid to remove cementless components before osseointegration, thereby removing potential biofilm-coated implants and surfaces. The current literature on this topic is very heterogeneous, reporting varying infection control rates with various intraoperative adjuncts (e.g., antiseptics, local antibiotics, etc.) combined with different postoperative antibiotic treatment courses. Successful and nearly equivocal results have been demonstrated with DAIR and Double DAIR for both primary and revision cementless total hip implants. Currently, there is no data on the scenario of an acutely infected cementless TKA, but with the recent rise in popularity of cementless TKA, future studies on this topic are needed/anticipated. In summary, there are many factors that more accurately predict the successful treatment of an acute postoperative infection in a patient who has cementless implants. Customized, patient-specific decisions to choose DAIR versus one-stage exchange revision should be made considering the acuity of infection, host and microbial factors, implant modularity, and

available sensitive antibiotics, though removal of non-osseointegrated implants is preferred if possible. Future studies are required to clarify the optimal treatment in this challenging cohort of patients.

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