SH66: What is the optimal surgical protocol for performing DAIR in patients with acute PJI?

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Response: The information available in the published literature does not currently aid in providing an answer to this question. Any literature that has any related information pertains to lower limb arthroplasty but remains vague on the protocol/technique.

Strength of Recommendation: Limited

Delegate Vote: 50 (94%) agree; 0 disagree; 3 (6%) abstain

Rationale: Use of surgical debridement and implant retention (DAIR) in prosthetic joint infection (PJI) management remains an area of debate in the literature, especially within shoulder arthroplasty. Not only on its effectiveness at eradicating infection but also on whether modular component exchange needs to occur as part of a DAIR procedure(1-3). DAIR management consists of prompt debridement with thorough removal of any necrotic tissue, purulent collections and debris around the implant, exchange of mobile arthroplasty components when possible, and prosthesis retention. After obtaining tissue samples, intravenous broad-spectrum antibiotics are administered, and treatment is adjusted according to microbiology sensitivities and microbiology specialty input. Intravenous administration is typically followed by oral antibiotics according to published treatment recommendations(37) similarly to lower limb PJI management(38).

An abbreviated systematic review was carried out according to the PRISMA checklist (Appendix 1). Following a thorough literature search by an information specialist, duplicate articles were removed and a total of 1172 articles were title and abstract screened according to the study question by the 2 authors (PR and AM) any conflicts were discussed, and consensus agreed. This provided 25 articles deemed potentially suitable and carried forward for full text review. Figure 1 demonstrates the PRISMA Flow chart for the literature screening process. The process yielded 6 papers salient to the study question(4-9). As the flow chart demonstrates a number were found not to discuss shoulder arthroplasty and therefore excluded following full text review.

How to perform a DAIR procedure optimally with a clear protocol that is replicable remains somewhat of a golden chalice. A key in the literature is the adequacy of debridement, which is difficult to quantify due to the subjectivity involved, but surgeons must ensure adequate visualisation of the whole joint including the subdeltoid spaces. Givens et al(4) felt this imperative, particularly in their cohort of patients treated with one-stage revision for infections. They discuss ‘the ability of the surgeon to assess the quality of debridement, which includes complete resection of any abnormal bone or tissue, removal of all tissue from around the glenoid, complete capsular resection, complete bursal resection, and debridement of the entire subdeltoid space including areas posterior to the humerus,’ all of which are basis for a good debridement.

Dennison et al(2) report on the inferiority of arthroscopically performed DAIR procedures, and an open DAIR procedure is advocated more definitively in other papers(10). One salient review article(11) proposes that only open debridement is suitable, and their results follow on from evidence in lower limb arthroplasty. The literature consistently reports

on the importance of antibiotics postoperatively with any empirical dosing narrowed as soon as sensitivities allow. These can be established from intraoperative cultures or preoperative aspirations or biopsies(12). Furthermore the importance of rifampicin for retaining prosthesis longevity due to its ability to fight against non-resistant bacteria in the biofilm. (13)

The appropriate timing of DAIR relative to symptom onset (a proxy for chronicity of the infection), does appear to be consistent in the literature, with much of the information following on from lover limb arthroplasty evidence. A team from Oxford highlight in hip arthroplasty that the likelihood of infection eradication was higher the sooner a DAIR was performed(14), this has also been reiterated more recently(15, 16). Patients presenting within 6 weeks after their shoulder arthroplasty operation but with acute symptoms of less than 3 weeks, or patients with symptoms less than 3 weeks at any time after any other duration post shoulder arthroplasty may be appropriate for DAIR management(12, 17, 18). In these cases, it was assumed that formation of biofilm would not yet be a profound issue allowing for thorough clearance but retention of implants. Similarly, a post operative regimen of 6 weeks total of antibiotics with a minimum of 2 weeks intravenously administered initially, followed by, if clinical and biochemical investigations confer, 4 weeks of oral antibiotics. The whole management should be done so under multidisciplinary team input and advice(1, 12, 19).

A number of reviews(20-25) and cases series(2, 10, 17, 18, 26-28) were found to discuss DAIR on abstract screening but on reviewing the full text no specific protocol or technique was advised for their DAIR procedure, emphasising the heterogeneity in the current available evidence. Kew et al(17) detail on 17 patients, within their shoulder PJI cohort of 65, undergoing DAIR procedures. They report, similarly to other studies, there being no uniform algorithm and treatment being decided by the individual surgeon. Bordure et al(6) report good outcomes in their cohort of chronic infection with retention of implants with good osseointegration with only modular component exchange with 91% of their cohort not experiencing recurrent infection discussing further the merits of retaining well fixed implants in the setting of infection and only modular exchange.

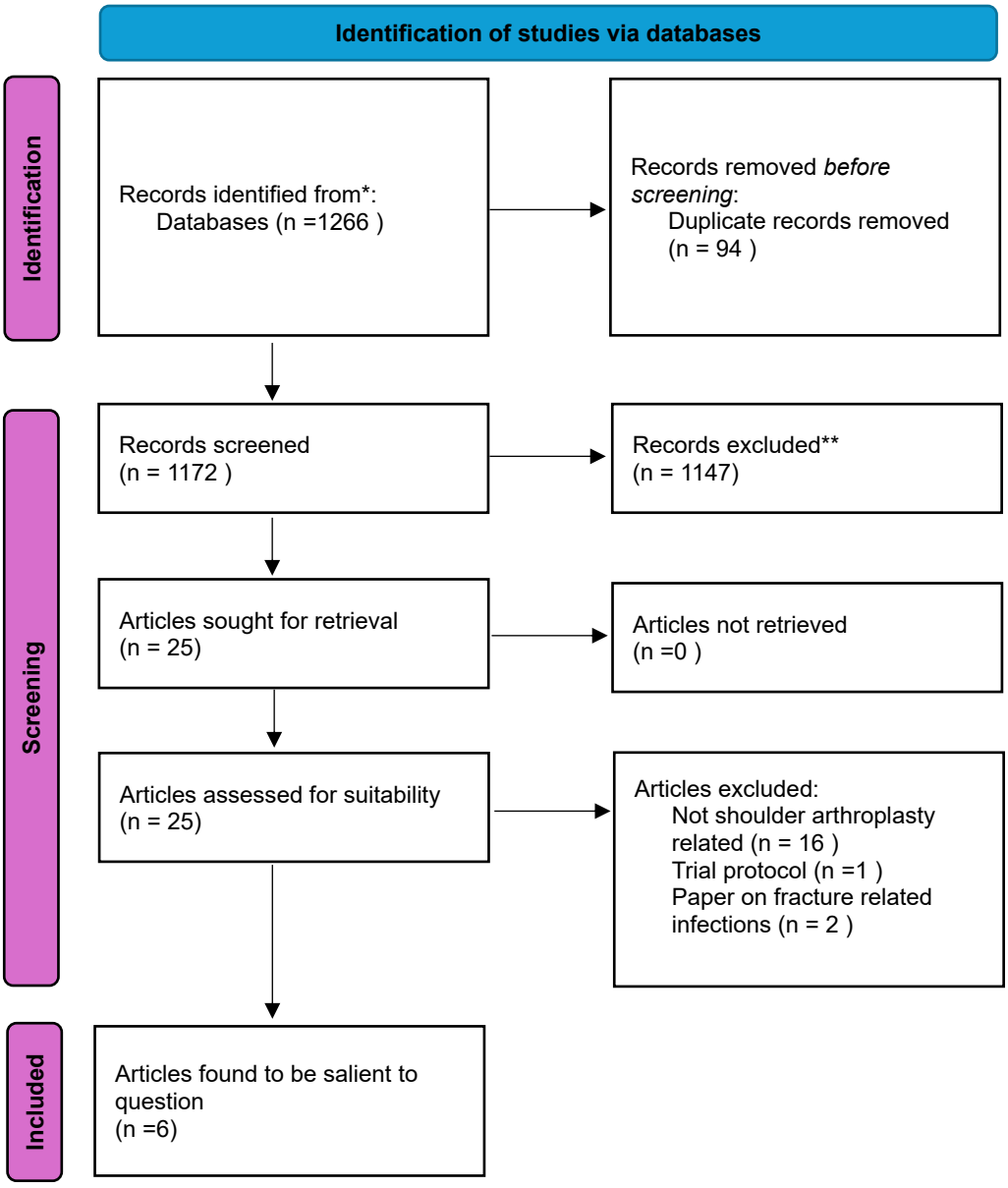
Through the literature screening it was clear that hip and knee arthroplasty have been trying to address this question for a number of years and their use of classifications such as KLIC and CRIME 80(9, 29) may offer some assistance in risk stratification for patients whom may be less successful in undergoing DAIR, whether this data is translatable to shoulder arthroplasty remains an area of uncertainty. Furthermore more longer term hip and knee arthroplasty cohorts have demonstrated factors such as younger age to be disadvantages for DAIR with a higher risk of revision due to recurrent infection(30).

Microbiology input continues to be an essential aspect of PJI management both in finding the organism but in suppressive treatment plans peri and post operatively(31). Cortes-Penfield et al discuss the literature on this thoroughly, discussing patient factors, organism factors and antibiotics factors for treating patients with suppressive antibiotic therapy following DAIR (32). One would consider, although from hip and knee arthroplasty, a lot of the findings pertinent when considering the treatment of the shoulder arthroplasty PJI cohort.

Debate continues in the literature of DAIR versus a staged procedure with some reporting a reinfection rate of 27%(28) to over 50 %(18, 20, 21, 33, 34) whilst others reports a fairly equivocal outcomes with a 2-staged revision procedure(17, 22, 35). Literature also provides little difference in single or double DAIR procedures which offers some further reiteration on the importance of a thorough initial DAIR procedure(36). All of these factors continues to make DAIR an area of discussion with no clear consensus (19).

Although discussion on irrigation use(31) and individual expert protocols are reported in hip and knee arthroplasty(8, 39). Clear surgical techniques and protocols are still required for DAIR procedures within shoulder arthroplasty.

Figure 1: PRISMA flow chart for What is the optimal surgical protocol for performing DAIR in patients with acute PJI?



References

1. Garrigues GE, Zmistowski B, Cooper AM, Green A, Abboud J, Beasley J, et al. Proceedings from the 2018 International Consensus Meeting on Orthopedic Infections: management of periprosthetic shoulder infection. Journal of Shoulder and Elbow Surgery. 2019;28(6, Supplement):S67-S99.
2. Dennison T, Alentorn-Geli E, Assenmacher AT, Sperling JW, Sánchez-Sotelo J, Cofield RH. Management of acute or late hematogenous infection after shoulder arthroplasty with irrigation, débridement, and component retention. Journal of Shoulder and Elbow Surgery. 2017;26(1):73-8.
3. Wright JO, Gehrke CK, Wiater JM, Weisz KM, Baker EA, editors. Applying the new shoulder periprosthetic joint infection consensus definition to a case series of revision

shoulder arthroplasty procedures to assess concordance between consensus definitions and diagnoses. Seminars in Arthroplasty: JSES; 2021: Elsevier.
4. Givens J, Schmidt CM, Patel R, Kucharik M, Grayson W, Chase C, et al. Factors affecting risk of recurrence with periprosthetic infection in shoulder arthroplasty. Journal of Shoulder and Elbow Surgery. 2024;33(6, Supplement):S80-S5.
5. Weber P, Utzschneider S, Sadoghi P, Andress HJ, Jansson V, Müller PE. Management of the infected shoulder prosthesis: a retrospective analysis and review of the literature. Int Orthop. 2011;35(3):365-73.
6. Bordure P, Marc C, Hubert L, Rony L. Does the retention of osseointegrated prosthetic implants during the surgical management of chronic infections following reverse total shoulder arthroplasty (RTSA) influence functional outcomes without impacting the efficacy of the infection treatment? Orthopaedics & Traumatology: Surgery & Research. 2021;107(4):102906.
7. Marinier MC, Mouser B, Ogunsola AS, Elkins JM. 'Tis Time 'Tis Time: The Importance of Operative Time, Thoroughness, and Shakespeare in Dair Procedures in Total Joint Arthroplasty. Iowa Orthop J. 2023;43(1):63-70.
8. Rizk PA, Deen JT, Pulido LF. When and how to retain implants in periprosthetic joint infection. Operative Techniques in Orthopaedics. 2021;31(4):100908.
9. Boyer B, Cazorla C. Methods and probability of success after early revision of prosthetic joint infections with debridement, antibiotics and implant retention. Orthopaedics & Traumatology: Surgery & Research. 2021;107(1, Supplement):102774.
10. Coste JS, Reig S, Trojani C, Berg M, Walch G, Boileau P. The management of infection in arthroplasty of the shoulder. The Journal of Bone & Joint Surgery British Volume. 2004;86-B(1):65-9.
11. Fink B, Sevelda F. Periprosthetic Joint Infection of Shoulder Arthroplasties: Diagnostic and Treatment Options. Biomed Res Int. 2017;2017:4582756.
12. Bdeir M, Dally FJ, Assaf E, Gravius S, Mohs E, Hetjens S, Darwich A. Periprosthetic Infections of the Shoulder Joint: Characteristics and 5-Year Outcome of a Single-Center Series of 19 Cases. Antibiotics (Basel). 2021;10(9).
13. Trampuz A, Zimmerli W. New strategies for the treatment of infections associated with prosthetic joints. Curr Opin Investig Drugs. 2005;6(2):185-90.
14. Grammatopoulos G, Kendrick B, McNally M, Athanasou NA, Atkins B, McLardy-Smith P, et al. Outcome Following Debridement, Antibiotics, and Implant Retention in Hip Periprosthetic Joint Infection—An 18-Year Experience. The Journal of Arthroplasty. 2017;32(7):2248-55.
15. Löwik CAM, Parvizi J, Jutte PC, Zijlstra WP, Knobben BAS, Xu C, et al. Debridement, Antibiotics, and Implant Retention Is a Viable Treatment Option for Early Periprosthetic Joint Infection Presenting More Than 4 Weeks After Index Arthroplasty. Clinical Infectious Diseases. 2019;71(3):630-6.
16. Wouthuyzen-Bakker M, Sebillotte M, Lomas J, Taylor A, Palomares EB, Murillo O, et al. Clinical outcome and risk factors for failure in late acute prosthetic joint infections treated with debridement and implant retention. Journal of Infection. 2019;78(1):40-7.
17. Kew ME, Mathew JI, Wimberly AC, Fu MC, Taylor SA, Blaine TA, et al. Outcomes after débridement, antibiotics, and implant retention for prosthetic joint infection in shoulder arthroplasty. Journal of Shoulder and Elbow Surgery. 2024;33(2):e68-e78.
18. Sperling JW, Kozak TK, Hanssen AD, Cofield RH. Infection after shoulder arthroplasty. Clin Orthop Relat Res. 2001(382):206-16.
19. Rangan A, Falworth M, Watts AC, Scarborough M, Thomas M, Kulkarni R, Rees J. Investigation and Management of Periprosthetic Joint Infection in the Shoulder and Elbow:

Evidence and consensus based guidelines of the British Elbow and Shoulder Society. Shoulder & Elbow. 2018;10(1_suppl):S5-S19.
20. Mercurio M, Castioni D, Iannò B, Gasparini G, Galasso O. Outcomes of revision surgery after periprosthetic shoulder infection: a systematic review. J Shoulder Elbow Surg. 2019;28(6):1193-203.
21. Marcheggiani Muccioli GM, Huri G, Grassi A, Roberti di Sarsina T, Carbone G, Guerra E, et al. Surgical treatment of infected shoulder arthroplasty. A systematic review. Int Orthop. 2017;41(4):823-30.
22. Nelson GN, Davis DE, Namdari S. Outcomes in the treatment of periprosthetic joint infection after shoulder arthroplasty: a systematic review. J Shoulder Elbow Surg. 2016;25(8):1337-45.
23. Aksoy T, Yilmaz A, Beydemir A, Yataganbaba A, Huri G. Comparison of surgical treatment options in periprosthetic shoulder infections: a systematic review from 2016 to 2022. Ann Jt. 2023;8:20.
24. Kunutsor SK, Beswick AD, Whitehouse MR, Wylde V, Blom AW. Debridement, antibiotics and implant retention for periprosthetic joint infections: A systematic review and meta-analysis of treatment outcomes. J Infect. 2018;77(6):479-88.
25. Faria G, Flood C, Muhammed AR, Narang A, Masood Q, Bakti N, Singh B. Prosthetic joint infections of the shoulder: A review of the recent literature. J Orthop. 2023;36:106-13.
26. Hirsiger S, Betz M, Stafylakis D, Götschi T, Lew D, Uçkay I. The Benefice of Mobile Parts' Exchange in the Management of Infected Total Joint Arthroplasties with Prosthesis Retention (DAIR Procedure). J Clin Med. 2019;8(2).
27. Byren I, Bejon P, Atkins BL, Angus B, Masters S, McLardy-Smith P, et al. One hundred and twelve infected arthroplasties treated with 'DAIR' (debridement, antibiotics and implant retention): antibiotic duration and outcome. Journal of Antimicrobial Chemotherapy. 2009;63(6):1264-71.
28. Stone GP, Clark RE, O'Brien KC, Vaccaro L, Simon P, Lorenzetti AJ, et al. Surgical management of periprosthetic shoulder infections. J Shoulder Elbow Surg. 2017;26(7):1222-9.
29. Bernaus M, Auñón-Rubio Á, Monfort-Mira M, Arteagoitia-Colino I, Martínez-Ros J, Castellanos J, et al. Risk Factors of DAIR Failure and Validation of the KLIC Score: A Multicenter Study of Four Hundred Fifty-Five Patients. Surg Infect (Larchmt). 2022;23(3):280-7.
30. Vries Ld, der Wv, Neve W, Das H, Ridwan B, Steens J. The Effectiveness of Debridement, Antibiotics and Irrigation for Periprosthetic Joint Infections after Primary Hip and Knee Arthroplasty. A 15 Years Retrospective Study in Two Community Hospitals in the Netherlands. J Bone Joint Infect. 2016;1(1):20-4.
31. Sousa R, Abreu MA. Treatment of Prosthetic Joint Infection with Debridement, Antibiotics and Irrigation with Implant Retention - a Narrative Review. J Bone Joint Infect. 2018;3(3):108-17.
32. Cortes-Penfield N, Krsak M, Damioli L, Henry M, Seidelman J, Hewlett A, Certain L. How We Approach Suppressive Antibiotic Therapy Following Debridement, Antibiotics, and Implant Retention for Prosthetic Joint Infection. Clin Infect Dis. 2024;78(1):188-98.
33. Lemmens L, Geelen H, Depypere M, De Munter P, Verhaegen F, Zimmerli W, et al. Management of periprosthetic infection after reverse shoulder arthroplasty. Journal of Shoulder and Elbow Surgery. 2021;30(11):2514-22.
34. Cooper ME, Trivedi NN, Sivasundaram L, Karns MR, Voos JE, Gillespie RJ. Diagnosis and Management of Periprosthetic Joint Infection After Shoulder Arthroplasty. JBJS Reviews. 2019;7(7):e3.

35. Paxton ES, Green A, Krueger VS. Periprosthetic Infections of the Shoulder: Diagnosis and Management. J Am Acad Orthop Surg. 2019;27(21):e935-e44.
36. Perez BA, Koressel JE, Lopez VS, Barchick S, Pirruccio K, Lee G-C. Does a 2-Stage Debridement Result in Higher Rates of Implant Retention Compared With Single Debridement Alone? The Journal of Arthroplasty. 2022;37(7, Supplement):S669-S73.
37. Rodríguez-Pardo D, Pigrau C, Lora-Tamayo J, Soriano A, del Toro MD, Cobo J, et al. Gram-negative prosthetic joint infection: outcome of a debridement, antibiotics and implant retention approach. A large multicentre study. Clinical Microbiology and Infection. 2014;20(11):O911-O9.
38. Boyer B, Cazorla C. Methods and probability of success after early revision of prosthetic joint infections with debridement, antibiotics and implant retention. Orthop Traumatol Surg Res. 2021;107(1s):102774.
39. Karlsen ØE, Snorrason F, Westberg M. A prospective multicentre study of 82 prosthetic joint infections treated with a standardised debridement and implant retention (DAIR) protocol followed by 6 weeks of antimicrobial therapy: favourable results. HIP International. 2025;35(1):62-9.

Appendix 1: Systematic Review Methodology

With assistance from a university information specialist, a comprehensive literature search was performed to identify all studies on irrigation and debridement with implant retention (DAIR) when treating acute shoulder PJI, and surgical protocol for performing DAIR in patients with acute PJI, benefit of multiple spacers in the setting of two stage (revision) with persistent positive culture. The search was performed in 2024 in four databases: Medline, Embase, Web of Science, CINAHL, Scopus, Cochrane, Clinicaltrial.gov and PubMed.

The search terms were Periprosthetic Joint Infection or Prosthesis-Related Infections, Shoulder or Shoulder Pain or Shoulder Joint or shoulder*, Shoulder Joint or Arthroplasty, Replacement, Shoulder or Arthroplasty, Replacement or shoulder* arthroplasty or Joint Prosthesis, Surgical Wound Infection or Shoulder Prosthesis or Anti-Bacterial Agents or intrawound shoulder or Vancomycin, Arthroplasty, Replacement, Shoulder/ or Prosthesis-Related Infections or Anti-Bacterial Agents or chronic shoulder* periprosthetic joint* infection* or Shoulder Joint, debridement, antibiotics and implant retention, Two-stage prosthesis exchange or, Two-stage prosthesis revision, persistent positive culture or positive culture, Orthopaedic/orthopedic Procedures or orthopaedic/orthopedic Surgical protocols or Postoperative Complications, antibiotic spacer or spacer*.

Inclusion criteria for the search were English language articles, all papers include the shoulder arthroplasty, or Periprosthetic Joint Infection.

Exclusion criteria were non-English language articles, animal studies, single case studies, case report studies, cancer, dentistry, knee, hip, ankle, spine, and elbow papers.

The systematic review software Rayyan was used to deduplicate the articles and for the literature screening process.