HK76: What, if any, are the indications for exchange of cement spacers?

Daniele De Meo; Paolo Adravanti; Ireneusz Babiak; Giorgio Cacciola; Dave Dipak; Antonio Russo; David T. Tarity; Hua Tian.

Response/Recommendation:
In cases of persistent infection during the interstage, spacer exchange may be performed; however, both the surgeon and the patient should be aware of the lower eradication rate associated with this procedure. For mechanical complications, the decision to exchange the spacer or proceed directly with an earlier reimplantation should be carefully weighed against the higher failure risk linked to spacer exchange.

Level of Evidence: Limited

Delegate vote:

Rationale

Periprosthetic joint infection (PJI) remains one of the most challenging complications in orthopedic surgery, often necessitating a staged revision approach. The exchange of a cement spacer during a two-stage exchange (TSE) procedure is a debated topic, with varying indications and outcomes reported in the literature. Spacer exchange rate span around 14% to 17% in literature [1-2].

A systematic review was conducted to identify the indications for spacer exchange and its associated outcomes. A comprehensive search of the Scopus and PubMed databases identified 566 studies for screening. After removing 211 duplicates, 355 studies were assessed. Inclusion criteria included the presence of a patient cohort undergoing interim spacer exchange, with clearly defined indications for the exchange and reported patient outcomes. After full-text assessment of 56 articles, 20 studies were included in the final analysis. All studies were classified as level III or IV evidence, with 18 retrospective cohort studies and only two prospective case series [2-21].

Current indications for an additional spacer exchange include persistent infection, wound-related complications, draining sinus, or mechanical issues such as spacer dislocation or fracture. However, the definition of persistent infection varies among studies due to heterogeneous criteria. Some authors rely solely on local clinical signs and inflammatory markers (e.g., C-reactive protein, CRP)[5, 8-11, 13, 16, 18-20], while others perform joint aspiration during antibiotic holiday to guide their decision based on culture results [4, 6-7, 12, 15, 21]. Additionally, some studies use scores made up by cell count and polymorphonuclear percentage for reinfection risk or preoperative open biopsy [17, 22].

In two studies, spacer exchange was performed as an intended strategy. Baeker et al. described a three-stage exchange protocol for patients with "difficult-to-treat pathogens," defined as pathogens lacking susceptibility to biofilm-active antibiotics (e.g., rifampicin-resistant staphylococci, ciprofloxacin-resistant gram-negative bacteria, and fungal infections), reporting an infection eradication rate of 88% [3]. Perry et al. analyzed outcomes of a multi-stage exchange strategy in knee PJI patients who were referred with a pre-existing spacer, regardless of signs of active infection. In their series of 54 cases, 45 patients achieved infection eradication (83%) [14].

Among the included studies, 13 compared infection eradication rates between the spacer exchange group and a standard TSE group [Table 1]. Patients undergoing spacer exchange

had lower infection eradication rates compared to those in a standard TSE approach (66.4% versus 78.4%). Additionally, increasing the number of spacer exchanges (one, two, or three) was significantly associated with a higher reinfection rate (10.5%, 40.0%, and 100%, respectively) ($p = 0.001$) [20]. Patients with spacer exchange fail to reach reimplantation more frequently. In their series, Gomez et al. reported that only 66% of patients that underwent spacer exchange ultimately reached reimplantation and spacer exchange was identified as an independent risk factor for treatment failure [23]. Klemt et al. performed a propensity score-matched analysis comparing patients who underwent spacer exchange with those undergoing a standard TSE, demonstrating a significantly increased reinfection risk in the exchange group (24% vs. 15%, $p = 0.03$) [12]. Their protocol involved antibiotic holiday, and the decision to exchange the spacer was based on preoperative aspirations and serologic tests. Similar findings were reported in other unmatched cohort studies [2, 19]. However, a separate propensity score-matched study by Frank et al. reached different conclusions, finding no significant differences in re-revision rates ($p = 1.00$) or reinfection rates ($p = 0.32$) [8]. In their study, the decision to reimplant or exchange the spacer was at surgeon's discretion and based on evaluation of inflammatory markers, clinical symptoms, and intraoperative findings, without an antibiotic holiday between stages.

The overall lower success rate observed in patients undergoing spacer exchange could be attributed to the underlying reasons necessitating the exchange itself [4]. Since these patients already exhibited signs of persistent infection despite spacer implantation, certain host-related or microbial factors may have rendered their infection less responsive to the standard protocol of debridement and antibiotic-loaded spacers. Therefore, additional studies are needed to enhance our understanding of why infections persist in spacers despite high-dose local and systemic antibiotic therapy.

Several comorbidities and pathogen characteristics have been identified as independent risk factors for interim failure and subsequent spacer exchange. A higher Charlson Comorbidity Index (odds ratio, 1.56; $P = .01$) and the presence of Enterococcus species (odds ratio, 1.43; $p = 0.03$) were significant risk factors [12]. Furthermore, Tan et al. reported that patients requiring spacer exchange had a significantly higher body mass index ($p < 0.001$), a higher prevalence of rheumatoid arthritis ($p = 0.018$), and were more likely to have PJI caused by polymicrobial organisms ($p = 0.007$) or antibiotic-resistant strains ($p = 0.048$) [2]. Jaubert et al. also identified resistance (OR=8.8; $p < 0.0008$) as a critical risk factor, along with the presence of gram-negative bacilli in hip aspiration (OR=3.7; $p < 0.026$) and methicillin-resistant *Staphylococcus aureus* (MRSA) in surgical samples from the first-stage procedure (OR 17.294; $p < 0.012$). Additional risk factors included a high ASA score ($p < 0.012$), chronic liver disease (OR 2.6; $p < 0.001$), a time to reimplantation exceeding eight months (OR 20.88; $p < 0.0001$) [24]; the lower age (adjusted OR = 0.95; $p < 0.001$), the use of mobile spacer (OR = 0.42; $p = 0.003$) and commercial spacers (OR = 0.25; $p = 0.029$) were protective factors for spacer exchange [25].

Regarding mechanical spacer complications, some authors advocate for shortening the interim period instead of performing a spacer exchange, whenever possible [13, 26]. In fact, spacer exchange has been shown to significantly impact functional outcomes. Klemt et al reported significantly lower postoperative scores for the hip disability and osteoarthritis outcome score physical function (46.0 vs 54.9, $p = 0.01$); knee disability and osteoarthritis outcome score physical function (43.1 vs 51.7, $p < 0.01$); and patient-reported outcomes measurement information system physical function short-form (41.6 vs 47.0, $p= 0.03$) [12].

In conclusion, the heterogeneity in study designs and reporting standards limits the ability to draw definitive conclusions. While certain indications, such as persistent infection, may

justify spacer exchange, further high-quality research is needed to establish standardized criteria and assess success rates compared to an earlier direct reimplantation. In conclusion, the decision to exchange a cement spacer should be carefully weighed against its potential risks, considering patient-specific factors and available clinical evidence.

References

1. Corona PS, Vicente M, Carrera L, Rodríguez-Pardo D, Corró S. Current actual success rate of the two-stage exchange arthroplasty strategy in chronic hip and knee periprosthetic joint infection. Bone Joint J. 2020 Dec;102-B(12):1682-1688. doi: 10.1302/0301-620X.102B12.BJJ-2020-0792.R1.
2. Tan TL, Goswami K, Kheir MM, Xu C, Wang Q, Parvizi J. Surgical Treatment of Chronic Periprosthetic Joint Infection: Fate of Spacer Exchanges. J Arthroplasty. 2019 Sep;34(9):2085-2090.e1. doi: 10.1016/j.arth.2019.04.016.
3. Baecker H, Frieler S, Geßmann J, Pauly S, Schildhauer TA, Hanusrichter Y. Three-stage revision arthroplasty for the treatment of fungal periprosthetic joint infection: outcome analysis of a novel treatment algorithm : a prospective study. Bone Jt Open. 2021 Aug;2(8):671-678. doi: 10.1302/2633-1462.28.BJO-2021-0002.R2.
4. Boelch SP, Jakuscheit A, Luedemann M, Heilig P, Kamawal Y, Arnholdt J, Rudert M. Do not exchange the spacer during staged TKA exchange! J Orthop. 2020 Dec 31;23:41-45. doi: 10.1016/j.jor.2020.12.022.
5. Cabo J, Euba G, Saborido A, González-Panisello M, Domínguez MA, Agulló JL, Murillo O, Verdaguer R, Ariza J. Clinical outcome and microbiological findings using antibiotic-loaded spacers in two-stage revision of prosthetic joint infections. J Infect. 2011 Jul;63(1):23-31. doi: 10.1016/j.jinf.2011.04.014.
6. Çağlar Ö, Tokgözoğlu M, Akgün RC, Atilla B. Low-dose vancomycin-loaded cement spacer for two-stage revision of infected total hip arthroplasty. Jt Dis Relat Surg. 2020;31(3):449-455. doi: 10.5606/ehc.2020.76108.
7. Clemente A, Cavagnaro L, Russo A, Chiarlone F, Massè A, Burastero G. Spacer exchange in persistent periprosthetic joint infection: microbiological evaluation and survivorship analysis. Arch Orthop Trauma Surg. 2023 Mar;143(3):1361-1370. doi: 10.1007/s00402-021-04300-5.
8. Frank BJH, Simon S, Aichmair A, Dominkus M, Hofstaetter JG. Clinical impact of microbiological results in two-stage revision arthroplasty with spacer exchange. Arch Orthop Trauma Surg. 2023 Aug;143(8):4741-4754. doi: 10.1007/s00402-023-04770-9.
9. George J, Miller EM, Curtis GL, Klika AK, Barsoum WK, Mont MA, Higuera CA. Success of Two-Stage Reimplantation in Patients Requiring an Interim Spacer Exchange. J Arthroplasty. 2018 Jul;33(7S):S228-S232. doi: 10.1016/j.arth.2018.03.038.
10. Hipfl C, Winkler T, Janz V, Perka C, Müller M. Management of Chronically Infected Total Knee Arthroplasty With Severe Bone Loss Using Static Spacers With Intramedullary Rods. J Arthroplasty. 2019 Jul;34(7):1462-1469. doi: 10.1016/j.arth.2019.03.053.
11. Kheir MM, Tan TL, Gomez MM, Chen AF, Parvizi J. Patients With Failed Prior Two-Stage Exchange Have Poor Outcomes After Further Surgical Intervention. J Arthroplasty. 2017 Apr;32(4):1262-1265. doi: 10.1016/j.arth.2016.10.008.
12. Klemt C, Smith EJ, Tirumala V, Bounajem G, van den Kieboom J, Kwon YM. Outcomes and Risk Factors Associated With 2-Stage Reimplantation Requiring an Interim Spacer Exchange for Periprosthetic Joint Infection. J Arthroplasty. 2021 Mar;36(3):1094-1100. doi: 10.1016/j.arth.2020.09.012.

13. Kozaily E, Tan TL, Yacovelli S, Anis H, Higuera C, Piuzzi NS, Parvizi J. Interim Spacer Exchange for Treatment of Periprosthetic Joint Infection: Almost Half the Patients Subsequently Fail. J Arthroplasty. 2022 Jan;37(1):150-155. doi: 10.1016/j.arth.2021.08.028.
14. Perry KI, Sproul RC, Sierra RJ, Abdel MP, Fehring TK, Hanssen AD. High Rate of Positive Cultures in Patients Referred With Antibiotic Spacers as Part of 2-Stage Exchange. J Arthroplasty. 2018 Jul;33(7):2230-2233. doi: 10.1016/j.arth.2018.02.059.
15. Pignatti G, Nitta S, Rani N, Dallari D, Sabbioni G, Stagni C, Giunti A. Two stage hip revision in periprosthetic infection: results of 41 cases. Open Orthop J. 2010 Jun 11;4:193-200. doi: 10.2174/1874325001004010193.
16. Schnetz M, Ewald L, Jakobi T, Klug A, Hoffmann R, Gramlich Y. Use of Hinged Implants for Multi-Stage Revision Knee Arthroplasty for Severe Periprosthetic Joint Infection: Remission Rate and Outcomes After a Minimum Follow-Up of Five Years. J Arthroplasty. 2025 Jan;40(1):218-226.e1. doi: 10.1016/j.arth.2024.07.035.
17. Springorum HR, Baier C, Maderbacher G, Paulus A, Grifka J, Goetz J. Periprosthetic Joint Infections of the Knee-Comparison of Different Treatment Algorithms. J Clin Med. 2024 Jun 26;13(13):3718. doi: 10.3390/jcm13133718.
18. Staats K, Boehler C, Frenzel S, Puchner SE, Holinka J, Windhager R. Failed Two-Stage Exchange: Factors Leading to Unachievable Endoprosthetic Reconstruction After Multiple Revision Surgeries. J Arthroplasty. 2018 Jan;33(1):195-199. doi: 10.1016/j.arth.2017.07.049.
19. Tsai ML, Herng-Shouh Hsu A, Wu CT, Lin PC, Tan TL, Kuo FC. Optimal reimplantation timing in two-stage exchange for periprosthetic joint infection: an observative cohort study in Asian population. BMC Musculoskelet Disord. 2024 Jan 2;25(1):28. doi: 10.1186/s12891-023-07129-8.
20. Vielgut I, Schwantzer G, Leithner A, Sadoghi P, Berzins U, Glehr M. Successful Two-Stage Exchange Arthroplasty for Periprosthetic Infection Following Total Knee Arthroplasty: The Impact of Timing on Eradication of Infection. Int J Med Sci. 2021 Jan 1;18(4):1000-1006. doi: 10.7150/ijms.47655.
21. Wichern EM, Zielinski MR, Ziemba-Davis M, Meneghini RM. Contemporary 2-Stage Treatment of Periprosthetic Hip Infection with Evidence-Based Standardized Protocols Yields Excellent Results: Caveats and Recommendations. J Arthroplasty. 2020 Oct;35(10):2983-2995. doi: 10.1016/j.arth.2020.05.028.
22. Ascione T, Balato G, Festa E, Pandolfo G, Siciliano R, Pagliano P. Ideal Timing of Reimplantation in Patients with Periprosthetic Knee Infection Undergoing 2-Stage Exchange: A Diagnostic Scoring System. J Bone Joint Surg Am. 2024 Jun 5;106(11):984-991.
23. Gomez MM, Tan TL, Manrique J, Deirmengian GK, Parvizi J. The Fate of Spacers in the Treatment of Periprosthetic Joint Infection. J Bone Joint Surg Am. 2015 Sep 16;97(18):1495-502. doi: 10.2106/JBJS.N.00958.
24. Jaubert M, Le Baron M, Jacquet C, Couvreur A, Fabre-Aubrespy M, Flecher X, Ollivier M, Argenson JN. Failure analysis of articulating polymethyl methacrylate spacers in two-stage revision total hip arthroplasty. Bone Jt Open. 2022 Jun;3(6):485-494. doi: 10.1302/2633-1462.36.BJO-2022-0024.R1.
25. Chang MW, Wu CT, Yen SH, Tan TL, Lin PC, Kuo FC. Influence of the Type of Bone Cement Used in Two-Stage Exchange Arthroplasty for Chronic Periarticular Joint Infection on the Spacer Replacement and Reinfection Rate. J Clin Med. 2023 Jan 11;12(2):600. doi: 10.3390/jcm12020600.
26. Yang FS, Lu YD, Wu CT, Blevins K, Lee MS, Kuo FC. Mechanical failure of articulating polymethylmethacrylate (PMMA) spacers in two-stage revision hip

arthroplasty: the risk factors and the impact on interim function. BMC Musculoskelet Disord. 2019 Aug 14;20(1):372. doi: 10.1186/s12891-019-2759-x.

Table 1: studies reporting the comparison of infection eradication rates between the spacer exchange group and a standard two-stage exchange (TSE) group. PSM: Propensity score matched.

Author, Year	Primary Country	Total N	Mean Age	Female N (%)	Joint(s)	Custom, molded, cumars	Local antibiotic	Static/articulated	Antibiotic holiday during interstage	Indication for spacer exchange	Spacer Exchange	Comparison	Comparison	Infection eradication Total # (%)	Infection eradication spacer exchange # (%)	Infection eradication control group # (%)
Boelch, 2021	Germany	60	67,8	39 (65%)	Knee	Custom-made	Gentamicin, Vancomycin	articulating	N	Infection persistence	8	TSE	52	48 (80%)	3 (37%)	7 (86%)
Caglar, 2020	Turkey	42	61	26 (62%)	Hip	Custom-made	Vancomycin	Articulating	Y	Infection persistence	5	TSE	37	39 (93%)	4 (80%)	35 (95%)
Frank, 2023	Austria	104	71	20 (38%)	25 hips; 27 knees	Molded or custom-made	n/a	Articulating and static	N	Infection persistence or mechanical complication	52	PSM TSE	52	84 (81%)	40 (77%)	44 (85%)
George, 2018	USA	347	65,8	180 (48%)	117 hips; 230	n/a	n/a	Articulating and static	Y	Infection persistence	59	TSE	288	236 (74%)	39 (66%)	227 (79%)

					knees										
Hipfl, 2019	Germany	97	70	56 (58%)	Knee	Custom-made	Gentamicin, Vancomycin	Static	N	Infection persistence	9	TSE	88	82 (84%)	6 (67%)	76 (86%)
Klemt, 2021	USA	245	66	82 (33%)	Hips and knees	Molded or custom-made	n/a	Articulating and static	Y	Infection persistence	49	PSM TSE	196	204 (83%)	37 (76%)	167 (86%)
Pignatti, 2010	Italy	41	59	25 (61%)	Hip	Preformed or molded	Gentamicin, Vancomycin, Meropenem	Articulating	Y	Infection persistence	9	TSE	32	41 (100%)	8 (100%)	32 (100%)
Springorum, 2024	Germany	66	65	25 (38%)	Knee	Custom-made	Gentamicin, Vancomycin	Articulating	Y	Spacer exchange during pre-reimplantation open biopsy per protocol	30	TSE	36	58 (88%)	27 (90%)	31 (86%)
Staats, 2018	Austria	44	66	17 (39%)	15 hips; 29	n/a	Gentamicin, Vanco	n/a	N	Infection persiste	22	TSE	16	23 (52%)	10 (45%)	12 (75%)

					knees		mycin			nce						
Tan, 2019	USA	533	66	46 (51%)	203 hips; 330 knees	Molded or custom-made	Vancomycin, Tobramycin	Articulating and static	n/a	Infection persistence or mechanical complication	90	TSE	443	319/425 (75%)	*37 (59%)*	*282 (80%)*
Tsai, 2024	Taiwan	361	62.6	179 (50%)	187 hips; 174 knees	Preformed or custom-made	Vancomycin, Piperacillin, Ceftazidime	n/a	Y	Infection persistence	61	TSE	300	334 (92%)	53 (87%)	281 (94%)
Vielgut, 2021	Austria	77	64.9	42 (54%)	Knee	Custom-made	Vancomycin	Static	Y	Infection persistence	17	TSE	57	60 (81%)	8 (53%)	51 (12%)
Wichern, 2020	USA	46	65.3	20 (43%)	Hip	Preformed, molded or custom-made	Vancomycin, Tobramycin	Articulating or static	Y	Infection persistence or mechanical complication	6	TSE	40	44 (96%)	5 (83%)	39 (97%)