HK52: Should modular components be exchanged during debridement, antibiotics, and implant retention for acute periprosthetic joint infection?

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Response/Recommendation:

Exchange of modular components at the time of debridement, antibiotics, and implants for the treatment of periprosthetic joint infection is associated with a lower risk of failure and is recommended, whenever feasible.

Level of Evidence: Moderate

Delegate vote:

Rationale:

Periprosthetic joint infections (PJI) are a devastating complication after arthroplasty associated with high clinical, psychological, and economical morbidity (1, 2). While implant preservation is desirable, treatment options for PJI are usually based on the type of infection, surgeon and patient preferences, and clinical factors (3). Debridement, antibiotics, and implant retention (DAIR) in defined circumstances provide lower morbidity compared to two-stage revision procedures (4). The rates of infection control with DAIR can vary significantly (5, 6). One factor that may affect the rate of infection control in DAIR may be modular component exchange (MCE) due to reduced bioburden and improved exposure to the effective joint space for more thorough debridement (5). However, the effect of MCE on failure rates of DAIR for the treatment of PJI remains unknown.

In multiple studies of large sample sizes, MCE showed no significant effect on the risk of failure after DAIR. However, these studies are at risk of bias from unmeasured confounding variables. Becker et al. assessed patients who have early PJI due to *Staphylococcus* sp. infection from four hospitals in France, finding no difference in failure with MCE (hazards ratio (HR) 1.19, 95% CI 0.36 to 3.92, $P = 0.78$) compared to those without MCE (7). Similarly, Rodriguez-Pardo et al. found no difference in failure with MCE (HR 0.73, 95% confidence interval (CI) 0.35 to 1.51; $P = 0.40$) or without when performing DAIR to treat PJIs secondary to Gram-negative organisms (8). In another study attempting to externally validate a preoperative risk score composed of chronic renal failure, liver cirrhosis, index surgery, cemented prosthesis, and C-reactive protein (KLIC) in a cohort of 386 patients in the Netherlands, Lowik et al. found no difference in failure with MCE within 60 days of initial debridement (MCE 58 versus no-MCE 63%; $P = 0.46$) (9). A multinational study conducted across Australia and New Zealand found no difference (OR 1.07, 95% CI 0.63 to 1.80; $P = 0.81$) with MCE in 352 patients (10). However, this study defined the primary treatment modality with a hierarchical structure, wherein patients undergoing DAIR followed by one- or two-stage revision within 90 days of diagnosis were recorded as having undergone one- or two-stage revision. Hence, the rates of failure following DAIR were likely under-reported in this study.

Multicenter studies show MCE was protective against failure after DAIR accounted for patient, surgical, and infection-related factors. A multinational study across the United States, Spain, Portugal, and the Netherlands found no difference in failure without MCE (odds ratio (OR) 1.70, 95% CI 0.96 to 3.00; $P = 0.07$) after adjusting for CRP, revision surgery, indication for index surgery, sex, and cemented implants (11). While not statistically significant, this result

may be a clinically important trend showing worse outcomes without MCE. Lora-Tamayo et al. found MCE was associated with lower rates of failure in PJIs secondary to *S. aureus* PJI (HR 0.65, 95% CI 0.44 to 0.95; $P = 0.03$) after adjusting for immunosuppressive therapy, bacteremia, polymicrobial infection, CRP, and the need for two or more debridements (12). A large study across 27 centers in the United States and Europe found significantly higher rates of success with MCE (MCE 30% versus no MCE 39%; $P < 0.001$). A random forest analysis found that not performing MCE was the fourth most important factor associated with failure (13). An international, multicenter study by Wouthuyzen-Bakker et al. including 340 patients found MCE was protective against failure of DAIR (OR: 0.35, 95% CI 0.18 to 0.67; $P = 0.002$) after adjusting for sex, age, hypertension, ischemic heart disease, heart failure, oral anticoagulant use, joint involvement, indication for index procedure, revision surgery, duration of symptoms, temperature > 38.5 C, physical signs of inflammation, CRP, leucocytosis, *S. aureus* infection, methicillin resistance, more than one DAIR, and use of local antibiotics (14). In a multicenter study across three centers in New Zealand, Zhu et al. found MCE was associated with a lower chance of failure (OR 0.51, 95% CI 0.32 to 0.81; $P = 0.004$) after adjusting for CRP, intraoperative purulent, *S. aureus* infection, and Gram-negative infection (15). Svensson et al. was the only study in this review that utilized an arthroplasty registry, finding MCE was protective for failure (HR: 0.51, 95% CI 0.38 to 0.68) after adjusting for primary diagnosis, sex, age, time from primary THA to symptoms, time from symptoms to DAIR, bacterial growth, and method of fixation (16). Deng et al. found higher rates of success in patients who have a sinus tract (MCE 26% versus no MCE 56%; $P = 0.04$), but did not adjust for any confounding variables (17).

Single-center studies also found mixed results, but offered limited insight due to their small sample size. Bartsch et al. reviewed 31 primary TKAs with early postoperative or acute hematogenous infections, finding no difference in failure with or without MCE in open DAIR (40 versus 44%, $P = 0.69$) (18). Similarly, no difference in failure was found with or without MCE in two studies published by Deirmengian et al. on the same cohort of 31 TKA patients (19, 20) and by Ottensen et al. in a cohort of 52 primary TKAs (MCE 22 versus no MCE 13%; $P = 0.44$) (21). There were two studies, including primary TKAs, that found MCE was associated with a significantly lower failure rate without adjustment for confounders (MCE 25 versus no MCE 100%; $P = 0.008$) (22), and after adjusting (MCE 47 versus no MCE 100%; $P < 0.001$) for age, sex, immunocompromise, diabetes mellitus, number of prior procedures, previous treatment for infection, revision surgery type of infection, isolated microorganism, and polymicrobial infection (23). However, DAIR without MCE had a 100% failure rate in both studies. In another study including 28 patients, open DAIR with MCE was compared with arthroscopic DAIR without MCE, finding that MCE was associated with lower odds of failures (OR 0.07, 95% CI 0.007 to 0.679; $P = 0.02$) after adjusting for age, gender, time from primary TKA to infection, time from symptom onset to DAIR, time from primary TKA to DAIR, previous ESR and CRP, type of microorganism, and Charlson Comorbidity Index (24). Koh et al. included both primary and revision TKA performed in 52 patients, finding no difference with MCE ($P = 0.14$), though only three patients did not undergo MCE (25). Sancho et al. assessed 64 patients who have acute PJI following THA and TKA from a prospectively maintained hospital database finding no difference with MCE (MCE 74 versus no MCE 67%; $P = 0.15$) (26). Chalmers et al. attempted to validate the KLIC and CRIME80 scores in a cohort of acute hematogenous PJIs in hip and knee arthroplasties, finding significantly lower rates of failure at 90 days with MCE ($P = 0.01$) (27). Of note, this study also included arthroplasties performed for fractures (6%) and revision surgery (22.4%). In another study including primary and revision THAs and TKAs, MCE was protective for failure (HR 1.90, 95% CI 1.20 to 2.90), after adjusting for infection due to MRSA, number of surgical interventions, and duration of

antibiotic treatment (28). Walkay et al. found no difference with MCE in 60 patients diagnosed with PJI more than two years after arthroplasty (MCE 28 versus no MCE 32%; $P = 0.73$) (29).

We also performed a meta-analysis of 17 studies reporting on failure in 3,568 patients. Modular component exchange was associated with a lower risk of failure after DAIR compared to DAIR without MCE (relative risk (RR) 0.68, 95% CI 0.54 – 0.86; $P = 0.001$; Supplement 1). Only one systematic review has been previously completed on this topic, utilizing meta-regression to assess the effect of the rate of MCE on success at the study level (30). This review included 65 studies finding no clear benefit to MCE in DAIR for the treatment of PJI in modern PJI practice. Rather, MCE was associated with a 3.1 to 3.5% higher success rate per 10% increase in MCE rate only among studies published before 2004.

Conclusion:

Modular component exchange at the time of DAIR was associated with lower rates of failure in 12 studies. These studies tended to account for relevant confounding factors. It is important to note, that no studies found MCE at the time of DAIR was associated with higher rates of failure. Studies that found no association of MCE with failure were of small sample size and did not adjust for other relevant factors. Based on the current evidence, modular components should be exchanged at the time of THA and TKA where feasible.

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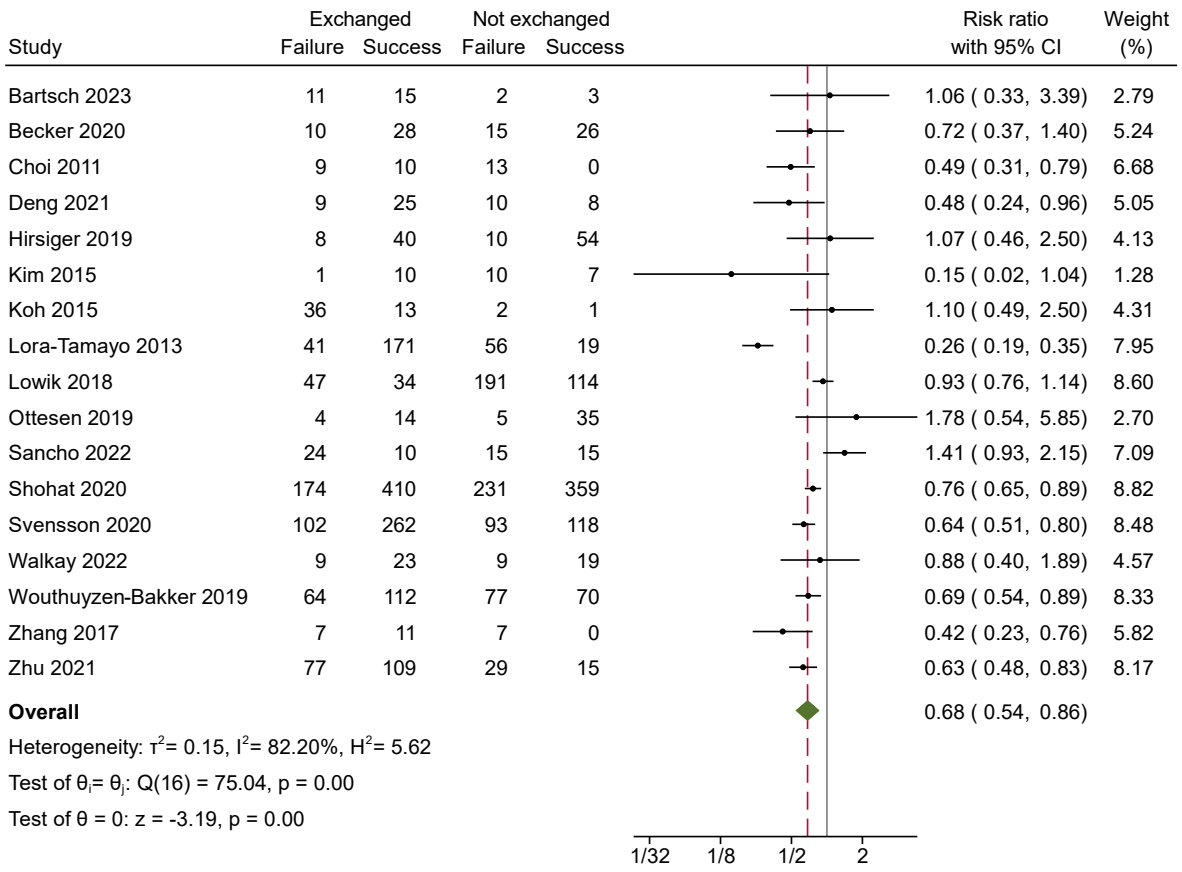
Supplement



Supplement 1. Forest plot for meta-analysis of studies comparing risk of failure associated with modular component exchange at time of debridement, antibiotics, and implant retention for treatment of periprosthetic joint infection.