G35: Does the use of pulsatile lavage influence the rate of surgical site infection (SSI)/periprosthetic joint infection (PJI) after major orthopedic procedures?

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Response/Recommendation:

There is no concrete evidence that the use of pulsative lavage influences the rate of surgical site infection (SSI) and/or periprosthetic joint infection (PJI).

Level of Evidence: Limited

Delegate Vote:

Rationale:

Periprosthetic joint infection (PJI) is the most common reason for hospital readmission following total joint arthroplasty (TJA), with an estimated incidence of approximately 1–2%.[1,2] The risk of developing a surgical site infection (SSI) is influenced by the degree of wound contamination at the time of surgery, as well as by the contaminating pathogens and their virulence.[3]
Nearly all surgeons use wound irrigation at the end of surgery, following the traditional orthopaedic maxim that "the solution to pollution is dilution".
Pulsatile lavage is one method for delivery of irrigation solutions to the surgical site. Pulsatile lavage was originally introduced by oral surgeons during the Vietnam War as a rapid method for irrigating heavily contaminated wounds.[4] Its mechanism of action relies on mechanical forces to remove debris, necrotic tissue, and micro-organisms from the surgical site.[5] Pulsatile lavage has been shown to be effective in reducing bacterial contamination on different surfaces[6] and plays an important role in treating patients with PJI.[7] High-pressure saline pulsatile lavage (0.34 N/mm^2) has been demonstrated to significantly reduce bacterial contamination in various types of wounds.[8,9]
However, potential negative aspects of using pulsatile lavage must be considered. An *in vitro* study on contaminated human tibial fractures found that high-pressure pulsatile lavage caused significant bone damage and intramedullary bacterial seedings.[10] Additionally, recent studies show that high-pressure pulsatile lavage may propagate bacteria into soft tissue[11].

In order to answer the question posed above, we performed a comprehensive systematic review. Using the MeSH terms developed by librarians, Pubmed and Embase databases were searched to identify relevant publications. Initially 543 articles were identified that were then screened by two independent reviewers to identify 35 studies that were then reviewed in full. Of the 35 assessed studies for eligibility, only one appeared to fit the inclusion criteria. Among the remaining 34 articles, 14 were not related to our search, 5 lacked a clear definition of SSI/PJI, and 3 had no available full-text. Additionally, 3 studies focused exclusively on adults with suspected PJI versus aseptic failure, 2 were not confined to the hip or knee, 2 were not human studies, 2 had aggregated data that were impossible to extract, and 1 was an expert opinion article. The only article that met the eligibility criteria[12] was a prospective randomized controlled trial, which was assessed as having 'some concern' regarding overall risk of bias according to the RoB2 tool and a moderate-to-low GRADE level of evidence quality.
A total of 356 hip surgeries were included in this study: 192 cases in the control group and 164 in the pulsatile lavage group. In the control group (192 cases), 30 cases of infection were reported, including

10 deep infections. In the pulsatile lavage group (164 cases), 9 infections occurred, with 3 classified as deep. Consequently, the overall infection rate was 15.6% in the control group compared with 5.6% in the pulsatile lavage group, while the deep infection rates were 5.6% and 1.8%, respectively.
The distribution of infection status was significantly different between the two groups. Specifically, deep infections were 10 (5.2%) in the control group compared to 3 (1.8%) in the pulsatile lavage group ($p<0.009$). Thus, we reject the null hypothesis that infection rates are the same in both treatment groups and conclude that there is strong evidence indicating a higher infection rate in the control group compared to the pulsatile lavage group.
Conclusion: The literature appears to be deficient in high level studies that evaluates the role of pulsatile lavage in prevention of surgical infections in patients undergoing orthopedic procedures. Although pulsatile lavage has been shown to be effective in reducing bacterial load in *in vitro* models, there is no concrete evidence (besides one level 1 study with limited number of subjects) that the use of pulsatile lavage is effective in reducing infection. Considering the potential posited concerns of using pulsatile lavage, namely transfer of superficial organisms from skin into deeper tissues, the economic and environmental cost associated with its use, and other concerns, we feel that a high level study with sufficient sample size is needed to explore this issue further.

References:

[1] Zimmerli, W.; Moser, C. Pathogenesis and Treatment Concepts of Orthopaedic Biofilm Infections. FEMS Immunol. Med. Microbiol.2012, 65, 158–168.
[2] Osmon, D.R.; Berbari, E.F.; Berendt, A.R.; Lew, D.; Zimmerli, W.; Steckelberg, J.M.; Rao, N.; Hanssen, A.; Wilson, W.R.; Infectious Diseases Society of America. Executive Summary: Diagnosis and Management of Prosthetic Joint Infection: Clinical Practice Guidelines by the Infectious Diseases Society of America. Clin. Infect. Dis. 2013, 56, 1–10.
[3] Owens CD, Stoessel K. Surgical site infections: epidemiology, microbiology and prevention. J Hosp Infect. 2008;70(2):3–10.
[4] Keblish DJ, DeMaio M. Early pulsatile lavage for the decontamination of combat wounds: historical review and point proposal. Mil Med. 1998 Dec;163(12):844-6. PMID: 9866365.
[5] Murray BW, Huerta S, Dineen S, Anthony T. Surgical site infection in colorectal surgery: A review of the nonpharmacologic tools of prevention. J Am Coll Surg. 2010;211(6):812–22.
[6] Bahrs C, et al. Lavage of contaminated surfaces: an in vitro evaluation of the effectiveness of different systems. J Surg Res. 2003;112(1):26–30. doi: 10.1016/S0022-4804(03)00150-1.
[7] Hawellek T, Beil FT, Hubert J. Revision surgery in acute periprosthetic knee joint infections. Oper Orthop Traumatol. 2018;30(5):309–320. doi: 10.1007/s00064-018-0558-4.
[8] Brown LL, et al. Evaluation of wound irrigation by pulsatile jet and conventional methods. Ann Surg. 1978;187(2):170–173. doi: 10.1097/00000658-197802000-00013.
[9] Rodeheaver GT, et al. Wound cleansing by high pressure irrigation. Surg Gynecol Obstet. 1975;141(3):357–362.
[10] Bhandari M, Adili A, Lachowski RJ. High pressure pulsatile lavage of contaminated human tibiae: an in vitro study. J Orthop Trauma. 1998;12(7):479–484. doi: 10.1097/00005131-199809000-00009.
[11] Hassinger SM, Harding G, Wongworawat MD. High-pressure pulsatile lavage propagates bacteria into soft tissue. Clin Orthop Relat Res. 2005;439:27–31. doi: 10.1097/01.blo.0000182246.37454.b2.
[12] Hargrove R, Ridgeway S, Russell R, Norris M, Packham I, Levy B. Does pulse lavage reduce hip hemiarthroplasty infection rates? J Hosp Infect. 2006 Apr;62(4):446-9. doi: 10.1016/j.jhin.2005.07.012. Epub 2006 Feb 20. PMID: 16488057.