SH43: Is postoperative stiffness associated with shoulder PJI? Should it be included in the minor criteria?

Liaison: Surena Namdari
Lead Delegate: Grant E. Garrigus
Supportive Delegates: Mark Lazarus
Supportive Author: Jennifer Kurowicki

Response/Recommendation: Shoulder stiffness is weakly associated with PJI and should not be included in the diagnostic criteria.

Strength of Recommendation: Limited

Delegate Vote: 49 (96%) agree; 0 disagree; 2 (4%) abstain

Rationale: A comprehensive literature review was performed to identify all studies that identified postoperative stiffness as a prognostic factor for periprosthetic joint infection (PJI) following shoulder arthroplasty. A search for shoulder arthroplasty [Title/Abstract] AND "Joint Stiffness"[MeSH] OR "Stiffness"[Title/Abstract] OR "Postoperative Stiffness"[Title/Abstract] AND "Prosthesis-Related Infections"[MeSH] OR "Periprosthetic Joint Infection"[Title/Abstract] OR "PJI"[Title/Abstract] was performed in the search engines PubMed and Scopus through October 2024. Inclusion criteria for our systematic review were all English studies (Level I-IV evidence) that reported on postoperative stiffness following shoulder arthroplasty in the setting of PJI. Exclusion criteria included non-English language articles, nonhuman studies, retracted papers, case reports, review papers, studies with less than <10 patients in the sample size, technique papers without patient data or did not specifically mention postoperative stiffness in setting of PJI. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria were followed.

Nonspecific complaints following shoulder arthroplasty, including stiffness, pain, and a lack of postoperative improvement, have traditionally been associated with shoulder periprosthetic joint infection (PJI). Although pain and stiffness are frequently described colloquially in the literature as potential indicators of infection, there is a notable absence of prospective, randomized studies assessing the prognostic value of postoperative stiffness. Additionally, there is no clear consensus among surgeons regarding the precise definition of postoperative stiffness.

Of the six studies included, four focused on patients presenting with nonspecific complaints such as pain, stiffness, or loosening without clinical signs of infection. The remaining two studies retrospectively reviewed cases of primary arthroplasties requiring revision. All studies were retrospective in design and derived from a single database under the direction of the same senior author.

There are 4 studies that retrospectively evaluate revision shoulder arthroplasty in the setting of nonspecific complaints such as pain, stiffness, or implant loosening[2-5]. One study reported on 193 revision shoulder arthroplasties presenting with these nonspecific complaints and found that 56% were associated with positive cultures[5]. Of those, 70% of the positive cultures demonstrated growth of Propionibacterium acenes (P. acnes), with 40.7% P. acnes alone and 28.7% P. acnes in combination with other organisms. Preoperative infectious markers, including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and white blood cell count (WBC), were elevated in

only 13%, 17%, and 9% of patients with positive cultures, respectively. While this study underscores the high association between nonspecific complaints and positive culture results, it does not differentiate which patients presented with pain, stiffness, or loosening—or a combination of these symptoms. Additionally, the study does not define "stiffness," limiting its applicability in assessing this specific complaint. Furthermore, a significant proportion of patients were identified preoperatively with radiographic loosening of glenoid components (61.9%) and humeral components (12%), suggesting a potential link between implant instability and underlying infection.

In a follow-up study involving 132 shoulders, which included 73 shoulders from the initial cohort, 66 shoulders were found to be culture-positive for *P. acnes*. Interestingly, the study noted that patients presenting with stiffness as the primary reason for revision were more likely to have *P. acnes*-negative cultures ($p<0.03$)[2]. Both studies indicated that male sex and younger age were more commonly observed in P. acnes culture-positive patients, suggesting potential confounding variables. This complicates determining whether stiffness is an independent variable or merely correlates with other factors associated with stiffness.

In another study of 55 shoulders with only pain, stiffness, or loosening undergoing single stage revision, 27 patients were found to be culture positive compared to 28 culture negative[3]. This study highlights that patients presenting with nonspecific complaints, such as stiffness, in the absence of overt signs of infection have nearly a 50/50 likelihood of yielding positive cultures. In both the culture-positive and culture-negative cohorts, three patients required additional procedures due to persistent pain or stiffness. Among the culture-positive cohort, no positive cultures were identified during the second revision. In the culture-negative cohort, *P. acnes* was detected in 1 out of 8 cultures at the time of the second revision for a single patient.

In the final study, the authors examined patients who underwent revision arthroplasty at least three years after the index procedure, presenting with a chief complaint of stiffness or loosening[4]. Among the 14 identified cases, performed an average of eight years after the initial arthroplasty, 79% of cultures were positive for *P. acnes*, and 18% were positive for coagulase-negative *Staphylococcus*. While the study did not distinguish between patients presenting with stiffness alone versus those with combined symptoms of stiffness and loosening, it underscores that even chronic or late-onset stiffness may be indicative of an underlying infection.

Two studies investigated risk factors for intervention following primary arthroplasty or shoulder periprosthetic joint infection. In a retrospective review of 998 patients with a minimum of two years of follow-up, 20 patients (2%) required reoperation. Among those, 85% reported persistent pain and stiffness, and 95% had positive cultures for *P. acnes*[1]. Additionally, patients who underwent ream-and-run arthroplasty exhibited a higher incidence of periprosthetic joint infection (PJI). A retrospective review of patients undergoing ream-and-run arthroplasty found that 8% required open revision for stiffness, with 69.2% of these cases showing more than two positive cultures for *P. acnes*[6]. The study recommended considering intervention for stiffness when forward elevation was less than 150° and failed to improve after at least six weeks of physical therapy, with open revision reserved for chronic stiffness lasting more than three months. Additionally, reduced passive forward elevation immediately postoperatively (125.7° vs. 143.3°; $p < 0.001$) was identified as an independent risk factor for requiring a repeat procedure.

References:

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