RATIONALE

HO is the presence of bone in soft tissue where bone does not exist. Several risk factors have been associated with HO such as spinal cord injury, head injury, neurologic disorders, osteoarthritis, male gender, burns, other trauma with severe soft tissue damage and joint arthroplasty. The presence of HO at an infected prosthetic joint may be encountered during the time of resection arthroplasty. HO should be removed if present within the infected area, if it interferes with adequate exposure and debridement or when it could potentially interfere with function after resection arthroplasty. Following surgical resection of the heterotopic bone, beneficial effects on the range of motion and pain relief have been described. However, there are still controversies about the optimal timing for surgical resection.

A perioperative regimen is crucial for recurrent prophylaxis. Non-steroidal anti-inflammatory medications (NSAIDs) and radiotherapy have demonstrated beneficial effects on HO prophylaxis with low recurrence rates for a number of indications such as total hip arthroplasty and acetabular surgery. Resection arthroplasty is an effective modality to treat hip arthroplasty infections with HO. If subsequently the patient develops HO while he or she is mobilized, it may facilitate walking on that hip [1].

However, in an extensive search of the English literature we were unable to find any relevant studies that investigate the effect of resection of HO at the time of resection arthroplasty on surgical outcomes.

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Authors: David Backstein, Maik Stiehler, Adam Katchy, Jennifer Leighton

QUESTION 7: When soft tissue coverage requires a reconstructive flap, can it be performed at the time of explant or should it be deferred until reimplantation?

RECOMMENDATION: When a soft tissue defect requires a reconstructive flap, it is safe to perform flap coverage at the time of explant or at the time of reimplantation. Early flap coverage at the time of explantation improves soft tissue biology for eradication of infection and allows for earlier mobilization following reimplantation given greater flap maturity.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 95%, Disagree: 2%, Abstain: 3% (Unanimous, Strongest Consensus)

RATIONALE

No prospective comparative studies were identified which compared patient groups who have had soft tissue reconstruction flaps performed at the time of explant versus at the time of reimplantation. Much of the literature pertinent to this question comprises heterogeneous series of patients who have exposed or infected total knee arthroplasty (TKA) implants. For TKA soft tissue defects, medial gastrocnemius rotational flaps were most commonly reported. However, many additional rotational and free flaps have been described: lateral gastrocnemius, latissimus dorsi, local fascio-cutaneous, quadriceps advancement, sartorius and rectus abdominus.

Tetreault et al. [1] published the only study identified which evaluated patients based on the timing of flap coverage. Treatment was based on surgeon opinion of insufficient soft tissues. The cohort was heterogeneous, including patients who received medial gastrocnemius flaps at the time of explantation, repeat spacer, reimplantation or irrigation and debridement with liner exchange. There was a non-significant trend toward higher failure rates when the flap was performed with spacer implantation (first or repeat) compared to definitive implants (reimplantation or retention with liner exchange). The overall reinfection rate among all groups was 52% at 4 years. Selection bias likely impacted these results and the authors clearly state that flap timing was based on necessity, rather than a belief that the timing was advantageous. Corten et al. [2] and Young et al. [3] described standardized staged protocols for the management of infected or exposed TKA implants, including soft tissue coverage at the time of explantation, with disparate results. While Corten reports 92% flap survival and one case of reinfection, patients in Young's series had a 29% amputation rate. Ries et al. [4] described a mixed cohort, which included seven patients who underwent soft tissue coverage at the time of spacer insertion. Four patients were treated successfully, while one flap failed and two went on to experience recurrent infection. Gerwin et al. [5] and Browne et al. [6] used flaps between revision stages and at the time of repeat spacer, respectively. Both series reported relative success, with 83% and 78% successful reimplantations, respectively.

McPherson et al. [7] reported on the only identified cohort of staged revision with flap during reimplantation. They described 5% recurrent infections and 33% wound complications among 21 patients.

Based on these published reports, there is limited evidence to support soft tissue flap reconstruction at the time of implant removal and antibiotic cement spacer insertion. By contrast, a small body of literature appears to support deferral of soft tissue coverage until reimplantation of a revision implant. However, these patient populations are not necessarily comparable within the limited body of evidence available. Most studies report high rates of complications, including recurrent infection, recurrent soft tissue defects and subsequent limb loss, highlighting the difficulty of this clinical problem regardless of treatment approach. Based on this literature, as well as experience, we prefer the former approach, given the benefits of improved soft tissue coverage and biology to the eradication of infection. Furthermore, performance of flap coverage at the time of explantation allows for unrestricted rehabilitation following later reimplantation.

Of note, numerous older studies were identified which describe the usage of soft tissue flaps to facilitate implant retention; however,

this approach is not considered consistent with modern, evidence-based management of exposed, infected arthroplasty implants.

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5.7. TREATMENT: PROSTHESIS FACTORS

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QUESTION 1: Does the use of cemented or cementless components at the time of reimplantation affect the success of treating chronic periprosthetic joint infections (PJIs)? If yes, what is the optimal antibiotic(s), dosage and cement to maximize antibiotic delivery and mechanical properties of the cement?

RECOMMENDATION: There is no evidence to suggest that the use of cemented or cementless components at the time of reimplantation affects the success rate of infection treatment. However, the mode of fixation may affect implant survivorship. The bone mass and the quality should dictate the choice of implant and the mode of fixation during reimplantation. If cemented prostheses are used, consideration should be given to the addition of antibiotics directed towards the infective organisms at the time of reimplantation.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 93%, Disagree: 4%, Abstain: 3% (Super Majority, Strong Consensus)

RATIONALE

Currently, both one-stage and two-stage revisions for the treatment of hip and knee PJIs have been reported with good results [1]. Regardless of the approach utilized, the optimal method of implant fixation (cemented versus cementless) for PJI treatment success at the time of reimplantation remains unclear. When dealing with septic revisions, the surgeon is faced with two goals: infection eradication and achieving durable fixation [2]. Cement fixation has many advantages including immediate fixation regardless of bone quality, the ability to impregnate with antibiotics/antifungals and the ability to secure impaction graft or large bulk allografts [2]. The disadvantages include sclerotic or limited periarticular bone necessitating longer stems with cementation into virgin cancellous bone further from the joint in question. In the event of reinfection, removal would be technically difficult with high morbidity. The advantages of cementless fixation include the benefit of long-term biologic fixation, ease of removal in the event of acute reinfection with lower morbidity and modularity to separately address implant fixation as well as restoration of biomechanics [2]. The overall survivorship of implants in revision surgery (aseptic and septic) has historically favored cementless fixation [3-8].

However, the literature does not support one method of fixation over another with regard to infection cure rate. Furthermore, there is no data to guide choice or dose of antibiotic to be used in the cement during reimplantation. The body of literature on fixation technique used at the time of reimplantation in two-stage procedures consists of very-low quality, small, single-center retrospective studies with only half providing adequate descriptions of the reimplantation procedure and/or whether cement was used (Table 1). The definitions for successful outcomes, antibiotic management postoperatively, adjunct antibiotic delivery devices (beads, allograft, etc.) and other aspects of surgical management were heterogeneous across different studies. Similar heterogeneous data has been reported for one-stage revision as summarized in a recent systemic review by George et al. [9]. To date, there has not been a randomized controlled trial to answer this question. Overall, cementless hips appear to be the most common approach during reimplantation with good clinical outcomes (83 - 95% successful outcomes). By contrast, when described, knee reimplantation with cemented components is common with comparable outcomes (76 - 93%, Table 1), but cementless or hybrid fixation is gaining popularity [8].

Few studies have specifically investigated the presence or absence of cement use with infection cure rates. Chen et al. explored risk factors for clinical failure following two-stage total hip arthroplasty (THA) revision for infection and a multivariate analysis did not demonstrate that cementation was associated with outcomes [10]. Sánchez-Sotelo et al. retrospectively reviewed 169 hips with infected arthroplasty, all of whom had two-stage reimplantation for the treatment of an infected THA [11]. In the second stage, the femoral component was fixed with antibiotic-loaded bone cement in 121 hips; the remaining femoral components and all acetabular components were cementless. The method of femoral component fixation, either with or without cement, did not correlate with risk of