

on antibiotic-loaded cement, depending on the inoculum and the type and dosing of the antibiotic agent [13,14]. Although Griffinet al. could not demonstrate biofilm formation in explanted spacers, Ma et al. demonstrated that 30.7% of spacers had bacterial contamination at the time of the second stage [15,16]. This laboratory data should give some cause for concern for the retention of cement in the setting of infection, even if loaded with antibiotics.

The clinical data on this topic is extremely limited. There are two case series that examine this specific issue, both involving a stable cement mantle in revision total hip arthroplasty for infection. Morley et al. reviewed 15 total hips with two-stage revisions for PJI while retaining the original cement mantle and reported infection-free outcomes in 14 of 15 patients [17]. The authors used a very strict selection criteria for the patient cohort. These selection criteria, which included a stable cement mantle, prior use of antibiotic-loaded cement and meticulous burring of the cement mantle in order to remove biofilm and liberate antibiotics were vital to the success of this technique. In a similar study, however, Leijtens et al. reported success in only 2 out of 10 patients undergoing two-stage revision total hip arthroplasty for infection at an average of 26 months [18]. It should be noted that this study did not mention whether the existing cement mantle contained antibiotics or not.

There is only one Level IV study showing good results with a retained stable cement mantle for later use in resection arthroplasty in the treatment of PJI. While this technique presents theoretical advantages, there is a lack of robust evidence in the literature to support its routine use. Direction for further research might include the use of chemical debridement agents, such as dilute povidone-iodine, chlorhexidine irrigation and/or acetic acid preparations, which some evidence suggests might help eradicating microbes and biofilms in some settings [19]. The role of chemical debridement agents in eliminating sessile bacteria and biofilm on the surface of retained cement has yet to be explored. With further research, the answer to this question might become known.

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QUESTION 3: Should surgeons make an effort to remove cement that has extruded into the pelvis or at difficult anatomical positions in patients with periprosthetic joint infections (PJIs)?

RECOMMENDATION: The orthopaedic surgeon should carefully consider whether the potential benefits of cement extraction from the pelvis or difficult anatomical positions outweigh the potential risks of persistence of infection.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 85%, Disagree: 9%, Abstain: 6% (Super Majority, Strong Consensus)

RATIONALE

Extrusion of cement during primary arthroplasty is reported to occur in 25% of patients [1]. Bacteria can form biofilm on foreign bodies in patients with PJI [2]. Therefore, in patients with PJI who

are undergoing resection arthroplasty, it is recommended that the prosthesis and all foreign material including bone cement be removed and thorough debridement performed. Whether or not

cement in the pelvis or in difficult anatomic positions contributes to the risk of persistent infection after revision arthroplasty has not been studied.

When cement is extruded into the pelvis or difficult anatomic positions during primary arthroplasty, there is a risk of neurological (obturator nerve palsy [3,4], femoral [5] or sciatic nerve involvement [6]), urological (such as a foreign body in the bladder wall [7]) or vascular (with compression of the external iliac vein [8]) complications. During extraction of extruded cement, the risk of these complications may be even greater due to the manipulation needed for extraction.

It is common wisdom and belief among surgeons that foreign material in an infected joint may harbor biofilm formed by the infecting organism. Leaving behind foreign material during resection arthroplasty and debridement, thus, runs the theoretical risk of allowing for biofilm and infection to persist and could therefore potentially jeopardize the success of surgical debridement. The latter dogma has actually never been proven in a conclusive study. It is also known that removal of foreign material, such as cement, from anatomically sensitive and/or inaccessible areas may require a wider surgical approach (such as laparotomy for extruded cement into the pelvis) or manipulation of structures such as organs (e.g., bladder, bowel), vessels (e.g., vena cava or major veins) or nerves (e.g., sciatic

or plexus). The manipulation of these structures may threaten the life of the patient and/or lead to catastrophic complications. Thus, we believe surgeons should exercise their wisdom when dealing with patients with PJI and extruded cement or other foreign materials in anatomically sensitive and/or inaccessible areas.

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QUESTION 4: Does the use of non-antibiotic-impregnated allograft for bone defects during reimplantation increase the risk of recurrence of surgical site infections/periprosthetic joint infections (SSIs/PJIs)?

RECOMMENDATION: There is no evidence to demonstrate that using non-antibiotic impregnated allograft for management of bone defects during reimplantation (following PJIs) increases the risk of recurrence of SSIs/PJIs.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 88%, Disagree: 9%, Abstain: 3% (Super Majority, Strong Consensus)

RATIONALE

Systematic reviews were undertaken using PubMed, Cochrane Library, SCOPUS and Google Scholars databases and relevant papers were reviewed. During review, it became evident that there is a dearth of information directly assessing treatment of PJIs when a non-antibiotic-impregnated allograft was used. Overall, 51 papers were reviewed in full. The evidence is summarized below.

Following the increased popularity of the use of allograft bone in tumor surgery in the 1970s [1], infection has become a major concern. The early reports of infection rates range from 13.2% by Mankin et al. [2] to 11.7% by Lord et al. [3] and were followed by 7.9% in a comprehensive report by Mankin et al. in 2005 [4]. All authors believed that higher rates of infection could be attributed to the disease nature, extent, duration and complexity of the procedures and not related to the allograft itself [2-4].

Tomford et al., in a retrospective study, reviewed 324 patients who received allografts and showed a negligible clinical incidence of infection. The incidence related to the use of large allografts was approximately 5% in bone tumor and 4% in revision of a hip arthro-

plasty [5]. These rates of infection were not substantially different from those that have been reported in similar series in which sterilized prosthetic devices were used [6]. One of the early reports of allografts in revision total hip arthroplasty (THA) was published by Berry et al. [6]. They used bone allografts in 18 patients during two-stage revision of septic THA failures. At a mean of 4.2 years after reimplantation, only two patients had a recurrence of the infection (11%).

Several retrospective cohort studies have evaluated the use of allograft bone during total hip reimplantation surgery, the second-stage of planned two-stage exchange arthroplasty for infection. The majority of these studies have demonstrated recurrent infection rates of 0-9% in cohorts consisting of 11-27 patients with mid- to long-term follow-up [6-12]. Two studies reported less favorable reinfection rates of 11% (18 patients, mean 4.2-year follow-up) and 14% (57 patients, mean 9-year follow-up) [13,14]. Traore et al. reported a higher rate of 20% for reinfection at mean 3 years [13]. Loty et al. reported a cohort of 90 cases with 8 (9%) reinfections over an unknown follow-up period in one-stage hip revision for infection [14].