While the removal of all implant materials is thought to provide the greatest benefit, the degree of tissue or implant excision necessary for infection control is currently unknown. The inability to control infection in the setting of retained hardware is often thought to be due to residual bacteria. In many cases, the morbidity of removing implants or other hardware is considered too great, and, therefore, implants are retained. Evidence for this is supported in the practice of debridement with retention of components. Partial radical debridement has proven successful in a small case series where 17 of 19 patients remained infection free with retained cemented or uncemented femoral prostheses [8,9]. In addition to the retention of metal components, there are mixed results when considering cement retention. McDonald et al. reported that 3 of 7 patients with retained polymethyl methacrylate cement had a recurrence of infection, whereas only 8 of 75 patients in which the cement had been completely removed had recurrence of an infection ($p < 0.01$) [10]. There is evidence, however, that retaining cement that would otherwise be deleterious to remove is safe and effective in the setting of infection [11].

The retention of plates, hooks or cables will often occur in the periprosthetic fracture setting. Evidence exists for successful fracture union with retained hardware in the setting of infection [12–14]. Berkes et al. demonstrated that 71% (86 of 121) successful fracture unions with operative debridement, retention of hardware and culture-specific antibiotics and suppression [12]. The retention of an intramedullary device, however, was associated with higher failure rates ($p< 0.01$). Rightmire et al. demonstrated a 68% (47 of 69 cases) success rate for hardware retention and debridement in the treatment of infected fractures [13]. When considering these results, it is important to note the clinical differences between infected fractures and infected periprosthetic fractures that communicate with the joint space, which is typically a large effective space. In postoperative spine infections, Picada et al. reported on 24 of 26 fusions healing without removal of hardware, although they achieved these results most often with secondary closure [15].

When retaining components, rifampin should be considered as part of the antibiotic regimen, particularly for staphylococcus infections. Zimmerli et al. conducted a randomized, placebo-controlled, double-blind trial and demonstrated a 12 of 12 (100%) infection control rate in the ciprofloxacin-rifampin group compared to the ciprofloxacin-placebo group (7 of 12 - 58%) when implants were retained [5]. Additionally, Trebse et al. demonstrated improved success rates with the addition of rifampin [9].

The removal of all infected material, organic or inorganic, improves the ability to control PJIs by reducing bacterial bioburden and helping to eliminate biofilm. However, the removal of these materials must be balanced with the morbidity of their removal and considered carefully in surgical planning.

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QUESTION 3: Should all knee compartments be resected during resection of an infected unicondylar knee arthroplasty (UKA)?

RECOMMENDATION: Yes, during resection of an infected UKA, other compartments of the knee, including the fat pad, should also be resected.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 80%, Disagree: 14%, Abstain: 6% (Super Majority, Strong Consensus)

RATIONALE

UKA has become increasingly popular among those affected by single-compartment osteoarthritis in that it preserves the integrity of the remaining knee compartments and ligaments, permitting the operated knee to be functionally and kinematically similar to the natural knee [1]. Similar to total knee arthroplasty (TKA), periprosthetic joint infections (PJIs) after UKAs can occur with reported rates ranging from 0.2 to 3% [2,3].

There is surprisingly minimal literature regarding the treatment and outcomes of PJIs after UKA. For chronic PJIs, Labruyère et al. demonstrated 100% survivorship in a series of nine infected UKAs treated with one-stage exchange arthroplasty to a TKA at a median of 60 months, five of which were initially unsuccessfully treated with synovectomy, joint lavage and antibiotics [2]. The authors also noted that wedges (n = 6) and stems (n = 5) were required in the majority of patients. Bohm et al. performed exchange arthroplasty in two cases of PJI with one resulting in a femoral amputation [4]. One study revised two cases via a second, single-stage UKA in conjunction with synovectomy and prolonged antibiotic therapy, with the new implants being the same size as the initial implant, and with one implant being cemented with antibiotic cement, while the other case did not have a cemented implant [5]. Four studies revised nine knees to a TKA [6–9], with one study having two re-revisions following initial resection for recurrent infection [9]. Furthermore, Hamilton et al. performed three two-stage exchange arthroplasties, with one initially undergoing irrigation and debridement but ultimately requiring revision to a TKA via a two-stage exchange arthroplasty for recurrent infection [10].

Three studies successfully treated deep infection following UKA with retention of the implant with the first reporting one case treated with debridement and inlay exchange [8], the second reporting two cases treated with washout, debridement and bearing/liner change [9] and the third reporting one case treated with synovectomy and placement of gentamicin chains [11].

It is clear through the current literature that there are several viable options to treat infections following UKAs. The method that the surgeon chooses to use should be selected based on the severity and chronicity of infection as well as the amount of remaining native bone and cartilage. Bone loss is also not uncommon in the setting of infection [5]. In acute infection and in the absence of involvement of other compartments, debridement and retention may be a reasonable option. In patients with bone loss, chronic infections, or with infections that may be difficult to eradicate due to a resistant or challenging organism, a one-stage exchange or two-stage exchange arthroplasty to a UKA or TKA may be performed with the inclusion of a wedge or stem as indicated. If two-stage exchange arthroplasty is being performed, during resection arthroplasty other compartments and the fat pad should also be resected as they may harbor bacteria. This practice also allows for insertion of a proper spacer.

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QUESTION 4: Can sub-radical resection arthroplasty (leaving parts of implants in place) be considered during management of patients with chronic periprosthetic joint infections (PJIs)?

RECOMMENDATION: **Sub-radical resection arthroplasty (leaving parts of implants in place) may be considered during management of patients with chronic PJIs when a component is proven to be well-fixed and its removal precludes opportunity for future reconstruction.**

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 68%, Disagree: 29%, Abstain: 3% (Super Majority, Weak Consensus)

RATIONALE

Two-stage revision with removal of all prostheses followed by reimplantation has been considered the gold standard to treat chronic PJIs [1–3]. However, the removal process might necessitate the use of additional procedures such as an extended trochanteric osteotomy to perform the removal of a well-fixed stem [4]. This can result in severe compromise of the proximal femur and jeopardize future fixation of a reimplanted stem. Retaining a well-fixed stem or acetabular component can be an option to avoid this in the setting of PJI treatment.

Struhl et al. [5] initially described this technique in 1989. In his case study, a 47-year-old man with a *Staphylococcus epidermidis* infection was treated by removal of the bipolar head, irrigation and debridement, retention of the femoral component and placement of antibiotic-impregnated beads. After seven weeks of intravenous antibiotic therapy, the patient underwent reimplantation of the acetabular component with an uncemented device. At 18-month follow-up, the patient had fully recovered without evidence of