HK75 - Is there a role for 1.5 stage exchange arthroplasty?

Guilherme Falotico, Gabriel Baron, Vaibhav Bagaria, Piers Yates, Giovanni Balato, James Nace, David Deckey, Christopher Jones

Response/Recommendation: The 1.5-stage revision does not show inferior results compared to the two-stage technique, with the advantage of reducing the number of additional surgical procedures.

Strength of recommendation: Weak

Delegate Vote:

Rationale:

Periprosthetic joint infection (PJI) is one of the most serious and difficult complications following joint arthroplasty.[1] Several procedures are available for the management of PJI, including DAIR (debridement, antibiotics, implant retention), single-stage revision and two-stage revision.[2] In chronic infections, two-stage revision has been considered the most effective treatment in most series, with the main drawback being the morbidity and cost associated with two separate surgical procedures.[3,4] The single-stage revision is an excellent alternative, particularly for patients with a competent immune system, a known pathogen, suitable antibiotic therapy options, and good soft tissue quality for wound closure; however, in cases of infection recurrence after a single-stage revision, the prognosis becomes compromised.[5]

Description of the Procedure: 1.5-stage revision arthroplasty has evolved as a relatively novel a surgical approach that is being increasingly employed to manage chronic PJI of the hip and knee. This technique combines elements of both single-stage and two-stage revisions. Typically, 1.5-stage revision involves the removal of the infected prosthesis and thorough debridement of the infected tissues. High-dose antibiotic-loaded bone cement is employed as fixation for the implants. In the knee, this typically involves a new femoral component and an all-poly tibia. In the hip, this may consist of both cemented femoral and acetabular components. The intent of this technique is that the implant remains *in situ* for an indefinite period, prolonging and perhaps obviating the need for a second-stage revision unless reinfection, deterioration of functional status, or construct failure occurs. In many cases, this 1.5 stage revision implant becomes the definitive or "destination" prosthesis. This method seeks to balance the benefits of prosthesis replacement, as seen in single-stage revisions, with some of the possible infection control advantages of the two-stage procedure.[6,7]

Indications: Current indications for this technique vary across institutions, with some centers utilizing 1.5-stage technique for the vast majority of PJI revisions. Other centres have focused 1.5-stage revisions on patients who are not deemed to be candidates for two major surgical intervention in a short period of time, patients with short survivorship in whom 1.5 stage is believed to suffice, hospitals that have limited resources for 2 major surgeries or patients that need time to recover prior to being subjected to another major reimplantation surgery. The contraindications for 1.5-stage revisions are more well defined; in the knee 1.5-stage revisions are contraindicated in patients with extensor mechanism deficiency, gross instability with collateral ligament deficiency, massive bone loss and soft tissue defects requiring flaps, in the hip 1.5-stage revisions are contraindicated in cases of massive femoral bone loss and/or recurrent instability.

Current Data: Festa et al.[19], in 2024, developed a systematic review to investigate if a 1.5-stage revision can be an effective alternative for chronic periprosthetic hip and knee infections. A meta-analysis was performed to evaluate the infection eradication rate using either the 1.5-stage revision or the 2-stage technique. A total of 494 patients (111 hips and 385 knees) who underwent 1.5-stage with a mean age of 69 years (range, 61 to 82) were identified in the ten included studies. The most common cause of reoperation was the conversion to the definitive prosthesis, followed by aseptic loosening. Infection control was reached in 84.6% of the 1.5-stage and 76.1% of the two-stage cohorts. The infection recurrence rate was higher in the two-stage cohort than the 1.5-stage group (21.8% versus 14.3%). The authors concluded that the 1.5-stage technique represents a valid treatment option in selected patients who have chronic periprosthetic joint infection who cannot undergo further surgeries, adding together the benefits of the 1- and 2-stage procedures.

Outcome of 1.5 Stage in TKA: In 2020, Siddappa & Meftah[8] described the outcomes of an articulated spacer in the treatment of chronic PJIs. Thirty-two patients with Methicillin-resistant *Staphylococcus aureus* (MRSA) infection were analysed. One patient progressed to transfemoral amputation due to intractable wound dehiscence. Of the 31 patients who remained with the spacer, infection control was achieved in 30 patients (97%), with follow-up ranging from 9 months to 3 years. Also in 2020, Hernandez et al.[9] evaluated 31 patients with an articulated spacer in the treatment of PJI. The average follow-up was 2.7 years, and 25 patients (81%) retained a functioning prosthetic joint. In 2021, Hooper et al.[10] studied the comparative outcomes of the 1.5-stage versus two-stage technique in the treatment of degenerative knee osteoarthritis secondary to septic arthritis. In the group that received one-stage functional prosthetic spacers, the survivorship free of any revision was 83% (CI: 82%-89%) at both 1 and 3 years, and the survivorship free of any revision was 100% (CI: 100%-100%) for the 9 (90%) patients who proceeded to second-stage surgery at both 1 and 3 years of follow-up.

In 2022, Siddiqi et al.[11] describes indications, contraindications, clinical outcomes, and pearls and pitfalls of 1.5-stage revision total knee arthroplasty (TKA) utilizing a primary TKA femoral component, all-polyethylene tibial component, and hand-crafted antibiotic cement for the management of chronic periprosthetic joint infection. This surgical technique paper found the 1.5 stage revisions to have equivocal outcomes with infection and patient reported outcomes, decreased health care costs, and decreased morbidity when compared to the to 2-stage revision. In the same year, Nabet et al.[12] examined all patients who underwent a 1.5-stage exchange TKA at a single institution compared to historical 2-stage controls. The authors analyzed all patients undergoing 1.5-stage (n=114) and 2-stage TKA exchange (n=48)with a mean 2.6-year follow-up. The infecting organism profile was similar between the 2 groups (Staphylococcus coagulase negative, 14.9% vs 16.7%, respectively; methicillin-sensitive *Staphylococcus aureus* (MSSA) 13% vs 12.5%, respectively; methicillin resistant staph aureus (MRSA) 11.4% vs 10.4%, respectively; culture negative 36% vs 44%, respectively). The 1.5-stage exchange TKA resulted in a 10.1% difference in infection-free survival (85.1% vs 75.0%, P=0.158) compared to 2-stage exchange. Postoperative complications were lower among 1.5-stage exchanges (8.8% vs 31.3%, $P < 0.001$) while The Knee Injury and Osteoarthritis Outcome Score, Joint Replacement (KOOS, JR)

scores improved more from baseline in the 1.5-stage group (24.7-point difference vs 16.6-point difference, P < 0.001) than those in the 2-stage cohort.

Finally in 2023, Belay et al.[13] reporting on 116 patients compared the clinical outcomes and costs associated with articulating spacers (1.5-stage) and a matched 2-stage cohort. There was no significant difference between groups with respect to the rate of reoperation (1.5-stage: 24.1% vs 2 stage: 25.9%, P=0.83) or the rate of infection clearance (1.5-stage: 79.3% vs 2-stage: 79.3%, P=1.0) after 2 years. There were no differences in the initial spacer surgery and 90-days cost, nevertheless they found a significantly higher overall cost for the 2-stage exchange through the first 2 years after the index surgery. Song et al.[14] investigated the aseptic survival of 1.5-stage exchange arthroplasty for periprosthetic joint infection (PJI) after total knee arthroplasty (TKA). Eighty-eight cases of 1.5-stage exchange arthroplasty for PJI without reinfection were retrospectively analysed. The autoclaved femoral component and new polyethylene insert (PE) were implanted using antibiotic mixed cement. The survival rates were 90.9%, 86.4% and 80.6% at 1, 2,and 5 years postoperatively, respectively.

In conclusion, the infection control rate with the 1.5-stage knee revision technique ranged from 79.3% to 100% with a minimum average follow-up of 1 year and was not inferior to the two-stage revision. The mechanical complications of the 1.5 stage components were acceptable, with 80.6% survival at 5 years of follow-up[14].

Outcome of 1.5 Stage in THA: In 2022, Charalambous et al.[15] studied the cost drivers in two-stage treatment of hip PJI with an antibiotic coated cement hip spacer and no significant difference in costs at 1- or 2-years for patients who received a “destination” or “1.5 stage” exchange arthroplasty. In 2023, Nace et al.[16] reviewed a consecutive series of 1.5-stage or planned 2-stage THAs. A total of 123 hips were included (1.5-stage: n = 54; 2-stage: n = 69) with mean clinical follow-up of 2.5 years (up to 8 years). The 1.5-stage exchange had 11% greater infection-free survivorship at final follow-up compared to 2 stages (94% versus 83%, P = 0.048). Morbid obesity was the only independent risk factor demonstrating increased reinfection among both cohorts. No differences in surgical/medical outcomes were observed between groups (P = 0.730). A total of 82% of 1.5-stage patients did not demonstrate progressive femoral or acetabular radiolucencies, while 94% of 2-stage recipients did not have femoral radiolucencies and 90% did not have acetabular one.

In 2024, Wang et al.[17] compared the clinical efficacy and complications associated with handmade spacers (group A) utilized during two-stage treatment and 1.5-stage functional articulating hip spacers (group B). They included 41 patients who had periprosthetic joint infections. All patients were followed up for at least 24 months after the last surgical procedure. No significant differences were noted in the infection eradication rate between the two groups (100 versus 96.30%, p=1.0). The incidence of mechanical complications, especially spacer fracture, was significantly lower in group B than in group A (p=0.044). Hip function and quality of life were significantly better in group B during the interim period. Group B patients had a longer interval time (median 7.40 versus 4.30 months, P =0.004) and a lower reimplantation rate than group A patients (42.31 versus 82.61%, P =0.004). The authors concluded that the 1.5-stage surgical technique is feasible for the treatment of hip infection, with a lower mechanical complication rate, better hip function, and better quality of life during the interim period compared to that of handmade spacers.

In conclusion, the infection control rate with the 1.5-stage hip revision ranged from 90 to 96.3% with a minimum average follow-up of 2 years and was not inferior to the two-stage

revision.[15-17] The mechanical complications of the 1.5 stage components were acceptable, with 82% patients did not demonstrate progressive femoral or acetabular radiolucencies.[17]

Cost Effectiveness: There are limited data regarding the cost effectiveness of 1.5 stage revision arthroplasty. In one study Okafor et al. (2023) evaluated the cost-effectiveness of one-stage versus two-stage revision surgeries for chronic PJI in TKA.[18] This study demonstrated that the incremental cost-effectiveness ratio (ICER) for two-stage revisions compared to one-stage was $231,000 per quality-adjusted life year (QALY), significantly exceeding the commonly accepted willingness-to-pay threshold of $50,000 per QALY. The probabilistic sensitivity analysis demonstrated that approximately 98.5% of simulations indicated that two-stage revisions are not cost-effective when compared to one-stage revisions.[18]

Challenges and Future Research: The importance of arthroplasty joint registries in establishing gold standards for implant survivorship and in some cases, patient reported outcome measures (PROMs) is well established. Arthroplasty national registries are databases that track joint replacement surgeries, such as hip and knee arthroplasties, to improve outcomes and monitor implant performance. Examples include the National Joint Registry (NJR) in the UK, the American Joint Replacement Registry (AJRR), the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR), and the Swedish Hip Arthroplasty Register. These registries collect data on patient demographics, surgical techniques, implant types, and complications like infections or revisions. At the time of writing, no national joint replacement registry has been able to accurately quantify and analyse the utilisation of the 1.5-stage revision prostheses in their cohorts. This remains a significant challenge internationally.
Likewise, there are limited data comparing 1.5 stage revision to single-stage revision, "two-in-one" stage revision and/or formal 2-stage revision. A well designed, large, international multicentre, randomised controlled trial comparing 1.5 stage vs 2 stage revision TKA and THA for PJI is an obvious direction for future research.

Conclusion:

The 1.5-stage revision is a treatment with equivalent outcomes, lower overall morbidity and potentially reduced cost than the classic two-stage exchange arthroplasty. Current considerations for this technique should include patients who are not deemed to be candidates for two major surgical intervention within a short period of time, patients with a short life expectancy in whom 1.5 stage is believed to suffice, patients that have limited resources or need time to recover prior to being subjected to another major reimplantation surgery. Multicentre prospective trials should be encouraged to further elucidate the role of 1.5-stage revision for PJI and validate the present findings.

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