

Comparing Survival to Revision and Reoperation in High-Risk Patients Undergoing Distal Femur Replacement With and Without Cones in the Femoral Diaphysis

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Introduction: Revision total knee arthroplasty (rTKA) rates are projected to increase by up to 600% from 2005 to 2030, reaching an estimated 268,000 annual cases. Survivorship for rTKA remains inferior to primary TKA. Distal femoral replacement (DFR) megaprotheses are a standard option in cases of severely deficient bone stock, with aseptic loosening as the leading cause of failure. Achieving diaphyseal fixation of the femoral component may improve implant survival. This study compared rates of revision and reoperation as well as survivorship between patients who received a DFR with a cone in the femoral diaphysis versus patients who received a DFR with no cone. This study also was designed to look for variables that increase or decrease the risk of revision and reoperation in both cohorts.

Methods: Following IRB approval, a retrospective review was conducted of adults undergoing DFR between January 1, 2003, and December 31, 2023. Patients were identified via billing codes for rTKA or TKA with a hinged prosthesis and confirmed by operative notes and imaging. Those with oncologic indications were excluded. Patients were grouped by presence or absence of a diaphyseal cone. The primary outcomes were revision (complete implant removal and replacement) and reoperation (any return to the OR not meeting revision criteria, e.g., modular component exchange, irrigation and debridement, hematoma evacuation, or fixation without component removal). Descriptive statistics were calculated and group comparisons used Mann-Whitney U and Fisher's exact tests. Kaplan-Meier survival and log-rank tests evaluated time to revision/reoperation. Cox regression analyses assessed predictors, including age, sex, indication, BMI, primary vs. revision DFR, number of prior procedures, construct dimensions, and cone use.

Results: 32 patients with 38 unique DFRs met inclusion criteria. 27 prostheses were without a femoral diaphyseal cone, 11 with a cone. Patients with a cone were on average, 71 years old (± 10.5 yrs), with a BMI of 37.0 (± 7.3 kg/m²), 88.9% white, 55.6% male, and 77.8% insured through Medicare/Medicaid. Patients without a cone were on average, 77 years old (± 7.3 yrs), with a BMI of 31.7 (± 7.6 kg/m²), 100.0% white, 17.4% male, and 73.9% insured through Medicare/Medicaid. None of these variables differed significantly between the two groups. Indication for DFR surgery significantly varied between cohorts ($p = 0.01$), with the majority of those with a cone indicated for periprosthetic joint infection (36.3%) or aseptic loosening (27.3%), and those without a cone indicated for fracture (29.6%) or periprosthetic fracture (29.6%). Patients with a cone had significantly more previous knee surgeries (5 ± 3 with cone vs. 2 ± 3 without cone, $p = 0.009$), including more previous DFRs. Log rank analyses showed cumulative survival to revision for any cause was not significant between groups ($\chi^2 = 0.002$, $p = 0.966$), nor was cumulative survival to re-operation for any cause ($\chi^2 = 2.232$, $p = 0.135$). At 3 years post-op (the last point at which data was available for both cohorts and both outcomes), cumulative survival to revision was 80% in those with cones and 60% in those without. Similarly, at 3 years post-op, cumulative survival to re-operation was 90% in those with cones and 43% without cones. 7.4% of patients without a cone required a revision due to aseptic loosening compared to 0.0% of patients receiving a DFR with a cone, however this was not significantly different. Variables including age, indication for surgery (fracture, nonunion, mechanical failure, multiple dislocations, PJI, periprosthetic fracture), BMI, primary or revision DFR, construct dimensions (stem length, stem diameter, total construct length, stem:length diameter ratio), and the presence or absence of a cone were not predictive of revision on Cox hazard analysis. However, it did appear that females had a significantly lower risk of revision surgery compared to males (HR = 0.097; 95%CI: 0.011-0.829; $p = 0.033$). Furthermore, patients indicated for DFR due to prior aseptic loosening had significantly higher risk of revision surgery compared to other indications (HR = 4.72; 95%CI: 1.00 – 22.29; $p = 0.050$). It was also found that each additional previous procedure increased the hazard of revision by 41% (HR = 1.41; 95%CI: 1.04 – 1.90; $p = 0.027$). No patient factors were predictive of reoperation.

Discussion: Based on the results of our analyses, the use of metal cones in the femoral diaphysis with a DFR implant did not significantly reduce the risk of revision or reoperation, nor did they appear to increase revision or reoperation survivorship in the study period. This is likely due to the fact that patients with greater baseline revision risk—more prior surgeries, prior DFR, and indications such as PJI or aseptic loosening—were more often treated with cones. These patients also had increased risk of revision when prior aseptic loosening or multiple previous procedures were present. Future studies, including longer follow up, may further elucidate specific patient populations in which the use of diaphyseal engaging cones may provide significant benefit patients with regards to implant survivorship, including sub analysis specific to patient indications for DFR of interest (i.e. revision in the setting of prior aseptic loosening or PJI), as well as controlling for the number of prior revisions a patient has undergone prior to the use of a cone. Similar to other studies, rates of complication and revision were high in our cohort, demonstrating both medical and anatomical challenges inherent to this patient population.

Clinical Relevance: The use of diaphyseal engaging cone in the setting of revision to DFR provides a comparable means of achieving fixation without increasing the risk of failure due to aseptic loosening in patient populations significantly at risk for further revision, including histories of increased number of prior revisions, and revision for indications involving compromised bone stock (i.e. PJI and prior aseptic loosening).

