Factors Related to Aseptic Loosening in Endoprosthetic Reconstruction of the Proximal Tibia

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INTRODUCTION:

Endoprosthetic reconstruction is frequently used after tumor resection in the proximal tibia. Among limb salvage procedures, proximal tibia replacement (PTR) is associated with the least favorable outcomes and highest rates of complications, with significant rates of infection, aseptic loosening, and mechanical failure. However, data on specific factors related to aseptic loosening in modern PTR implants are lacking.

METHODS:

This was a retrospective review of patients who underwent endoprosthetic reconstruction for tumors of the proximal tibia from 1998 to 2024. The primary endpoint was aseptic loosening, defined as radiographic evidence or intraoperative confirmation of loosening. Demographic and clinical variables collected included age, sex, primary tumor diagnosis, use of chemotherapy and radiation therapy, bone resection length, stem diameter, and tibial prosthesis length. Radiographic measurements were also collected to assess fill of the canal by the implant stem. The ratios of the width of the medullary canal to the width of the implant stem at the tibial and femoral diaphysis and femoral metaphysis were measured on anteroposterior (AP) and lateral radiographs. Patient and implant survival were determined with Kaplan Meyer analysis. Cox proportional hazards regression was used to identify factors associated with aseptic loosening and other modes of failure.

RESULTS: Sixty patients treated with PTR for proximal tibia tumors were included in the study. All cause revision-free survival was 56% at 5 years and 30% at 10 years. Overall, 9 patients developed aseptic loosening (15%); of these, 7 (11.7%) developed femoral loosening while 4 developed tibial loosening (6.7%). When compared to patients with stable implants, patients with aseptic loosening had smaller femoral stem size (median 13.0 mm, range 11.0-17.0 vs median 16.0 mm, range 13.0-21.0, $p<0.001$), and more frequent use of neoadjuvant chemotherapy ($p=0.04$) and radiation therapy ($p=0.03$). On univariate analysis, tibial stem size greater than 11 mm was associated with reduced risk of aseptic loosening (odds ratio (OR) 0.23, 95% confidence interval (CI) (0.05-0.99); $p=0.048$). Larger femoral stem size (OR 0.27, 95% CI (0.10-0.52); $p<0.001$), and specifically femoral stem size greater than 15 mm (OR 0.03, 95% CI (0.00-0.19); $p<0.001$) were also associated with a lower risk of aseptic loosening. Higher femoral AP ratio (OR 34.5, 95% CI (3.59-630); $p=0.001$), femoral metaphysis AP ratio (OR 17.3, 95% CI (3.57-165); $p<0.001$), and femoral metaphysis lateral ratio (OR 5.73, 95% CI (1.04-40.3); $p=0.045$) were associated with a higher risk of aseptic loosening. Loosening of the tibial implant was associated with loosening of the femoral implant (OR 7.57, 95% CI (1.26-45.56), $p=0.01$). When controlling for potentially confounding variables, femoral stem size less than 15 mm was significantly associated with aseptic loosening (OR 14.7, 95% CI 2.19-145.28; $p=0.005$).

DISCUSSION AND CONCLUSION:

These findings highlight the importance of careful implant selection in PTR following tumor resection, particularly regarding femoral stem size. Femoral canal fill by the implant stem, as measured on AP and lateral radiographs, may help clinicians select the optimal stem size to reduce the risk of loosening. Further studies are needed to explore strategies to improve implant longevity and reduce complications in this high-risk population.

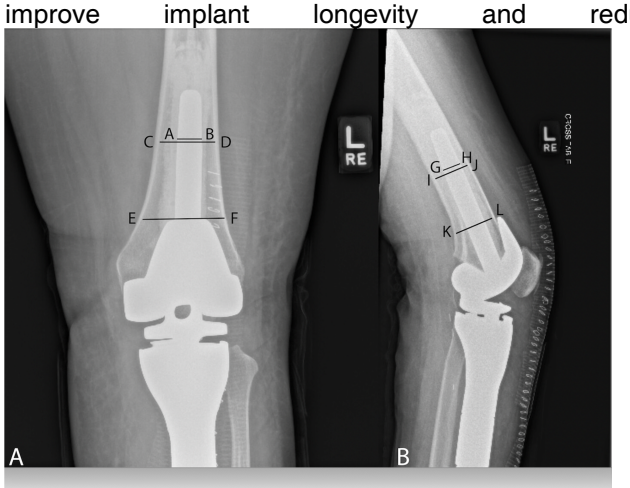

Figure 1. Diagram of femoral radiographic parameters on anteroposterior (A) and lateral (B) radiographs. Femoral anteroposterior (AP) ratio = CD/AB, femoral metaphysis AP ratio = EF/AB, femoral lateral ratio = IJ/GH, femoral metaphysis lateral ratio = KL/GH.