Factors Influencing Tibial Loading Following Total Knee Arthroplasty: A Finite Element Study
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Prosthetic alignment, patient characteristics and implant design are all factors in long-term survival of total knee arthroplasty (TKA), yet the level at which each of these factors contribute to implant loosening has not been fully described. Prior clinical and biomechanical studies have indicated tibial overload as a cause of early TKA revision. The purpose of this study was to determine the relationship between tibial component design and bone resection on tibial loading. A validated, specimen-specific finite element mesh was generated from CT scan data of a composite tibia. FEA was performed after simulated implantation of metal backed and all-polyethylene TKA components in 5 and 15 mm of tibial resection. Proximal tibial strains significantly increased between 13% and 199% when implanted with all-polyethylene components (p<0.05). Strain significantly increased between 12% and 209% in the posterior tibial compartment with increased bone resection (p<0.05). Long-term results with this all-polyethylene component design have been poor, with clinical failure primarily due to loosening and medial bone collapse. This study indicates elevated strains in all-polyethylene implanted tibiae across the entirety of the proximal tibial cortex, as well as a posterior shift in tibial loading in instances of increased resection depth. These results are consistent with trends observed in prior biomechanical studies and may associate the documented device history of tibial collapse in all-polyethylene components with increased bone strain and overload beneath the prosthesis.