Aseptic Failure of Revision Total Knee Arthroplasty Tibial Components with Sleeves: A Novel Radiographic Study of Zonal Fixation

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INTRODUCTION:

Revision total knee arthroplasty volume is increasing, posing significant resource utilization for surgeons. Improving revision implant survivorship by better understanding modes of implant failure is valuable. Lack of medial base plate support and undersized tibial sleeves and stems are hypothesized to contribute to aseptic loosening and varus collapse of revision total knee arthroplasty tibial components with sleeves.

METHODS:

Completed a retrospective case series of patients re-revised for aseptic loosening of revision tibial components with sleeves at a single academic institution from 2011-2024. AP and lateral knee radiographs following index revision TKA with sleeve components used to measure stem-to-endosteal canal fill ratios. A novel technique was developed with ImageJ software to measure area fill ratios of implant-to-endosteal canal area over the length of the tibial sleeve and stem in the metaphysis and diaphysis, respectively. Medial baseplate support graded as unsupported or supported on post-operative radiographs. Implants considered unsupported with gapping underneath the baseplate (>2mm) secondary to bone loss or with excessive cement mantle (>2mm) in place of implant augments.

RESULTS: 21 patients revised for aseptic loosening of tibial components with sleeves, the majority (52.3%) with lack of medial baseplate support on post-operative radiographs. The average diaphyseal stem AP and lateral fill ratios were undersized at 0.81±0.13 (avg±SD) and 0.78±0.14, respectively. Using area fill ratio method, the distal 4cm of the AP and lateral diaphyseal stems were more notably undersized measuring 0.74±0.1 and 0.68±0.11, respectively. Smaller stem area fill ratio (distal 4cm) compared to Parsley fill ratio of stem tip suggests traditional methods under size and do not account for shape mismatch of implant stem with tapered tibial canal. The average metaphyseal sleeve AP and lateral area fill ratios were 0.55±0.1 and 0.50±0.07.

DISCUSSION AND CONCLUSION: Undersized stems and/or sleeves with an unsupported medial base plate may contribute to aseptic failure of sleeves in revision TKA. Area fill ratio is a novel technique that provides a comprehensive and objective measurement tool to assess tibial stem-endosteal contact area. Further investigation is needed to understand appropriate sizing of metaphyseal sleeves.

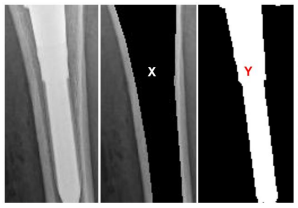

Figure 4: *Area Fill Ratio.* (Left) Original tibia radiograph. (Center) ImageJ detects endosteal canal and calculates percent area of image in black (X). (Right) ImageJ detects percent area occupied by implant (Y). Area fill ratio calculated as ratio of Y/X. Calculation for implant distal to sleeve as well as separately for distal-most 4cm of stem only.[5]

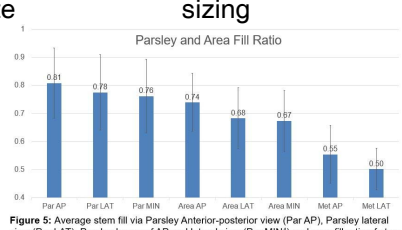

Figure 5: Average stem fill via Parsley Anterior-posterior view (Par AP), Parsley lateral view (Par LAT), Parsley lesser of AP and lateral view (Par MIN[4]) and area fill ratio of stem AP view (Area AP), lateral view (Area LAT), and lesser of AP and lateral view (Area MIN), and metaphyseal sleeve AP view (Met AP), and lateral view (Met LAT) in 21 patients.

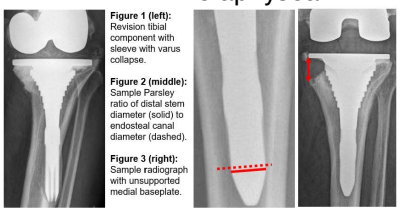

Figure 1 (left): Revision tibial component with sleeve with varus collapse.

Figure 2 (middle): Sample Parsley ratio of distal stem diameter (solid) to endosteal canal diameter (dashed).

Figure 3 (right): Sample radiograph with unsupported medial baseplate.