A Biomechanical Comparison of Standard versus Far Cortical Locking Screws in a Periprosthetic Distal Femur Fracture

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Purpose: The incidence of periprosthetic fractures in the population continues to rise. As these patients are elderly and likely to have comorbid medical conditions, it is necessary to stabilize the fracture with fixation that will facilitate bone healing. Our purposes were: (1) demonstrate a periprosthetic fracture model that can be used for future studies and (2) biomechanically evaluate construct stiffness and fracture gap motion with periprosthetic plates comparing standard locking with far cortical locking screws in the diaphyseal segment.

Methods: Ten paired cadaveric femurs were obtained. The femurs had no prior implants. All femurs were determined to be osteopenic or osteoporotic by DXA (dual x-ray absorptiometry) scans. Specimens had a femoral total knee component placed to simulate a periprosthetic model. We then placed a 9-hole periprosthetic locking plate with either standard locking screws or far cortical locking screws in the diaphysis (holes 3, 5, 7, and 9). All plates were fixed distally with 5 standard locking screws. A distal femoral fracture was then created with a 1-cm lateral and 3-cm medial gap, simulating an extra articular periprosthetic fracture model. The osteotomies were standardized to ensure the gap level was identical in all constructs. Specimens were potted and loaded on the MTS machine and tested to axial failure. Stiffness of the construct and micromotion were recorded at the fracture gap.

Results: The standard locking screw (SS) construct stiffness was significantly higher when compared to the far cortical group (FC) ($P < 0.05$). The average micromotion in the FC group was 1.12 times higher than the SS group, but did not reach statistical significance ($P = 0.476$). All FC constructs failed at the far cortex of the most distal diaphyseal screw. All SS constructs also failed at the distal most diaphyseal screw, however, 6 of 10 failed on the side of the locked plate. Location of primary failure was significantly different between the two groups ($P = 0.010$).

Conclusion: Our periprosthetic fracture model demonstrates an FC construct was significantly less stiff than standard locked screws. Recent literature has suggested that decreasing the rigidity of the construct may aid fracture healing by allowing micromotion at the fracture site. In our model, no statistical significance was noted in micromotion, although the average motion at the fracture gap was higher in the FC construct than the standard locking screw construct. This information could be applied in consideration of controlling construct stiffness and possibly fracture healing.

See pages 47 - 108 for financial disclosure information.