Periprosthetic Supracondylar Femoral Fractures Following Knee Arthroplasty: A Biomechanical Comparison of Four Methods of Treatment

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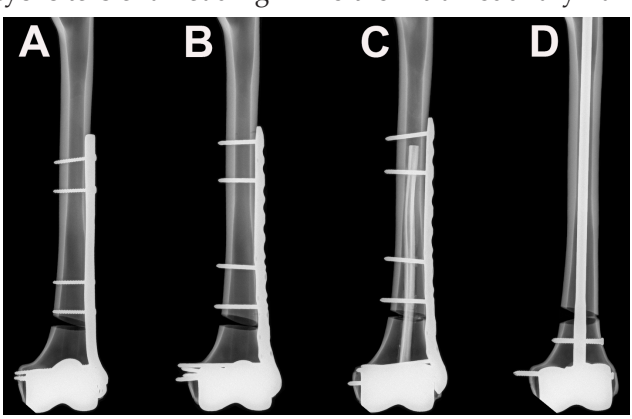
Purpose: Controversy exists over the optimal fixation of distal periprosthetic femoral fractures. The purpose of this study was to determine the biomechanical stability of a periprosthetic supracondylar femur fracture stabilized with either a nonlocking plate, a polyaxial locking plate, a polyaxial locking plate augmented with an intramedullary fibular strut graft, or a retrograde intramedullary nail. We hypothesized that the polyaxial locking plate augmented with an intramedullary fibular strut graft would provide improved fixation of the distal femoral fragment compared with the intramedullary nail or polyaxial locked plate alone.

Methods: Twenty large-sized fourth-generation composite femurs (Sawbones, Pacific Research Laboratories) simulating osteoporotic human bone were used in this study. A NexGen LPS-Flex femoral component was implanted on all the specimens using bone cement. The specimens were divided to 4 groups (5 specimens in each group): A, nonlocking plate (Zimmer Periarticular Plating System); B, polyaxial locking plate (Zimmer NCB Periprosthetic Femur Plate System); C, polyaxial locking plate augmented with an intramedullary fibular strut allograft (Zimmer NCB Periprosthetic Femur Plate System); and D, retrograde intramedullary nail (Zimmer Natural Nail System) (Fig. 1). Following instrumentation, a metaphyseal-diaphyseal defect was created simulating an AO/OTA 33-A3 fracture pattern. The specimens were mounted on an Intron ElectroPulse E10000 universal mechanical testing machine. In nondestructive cyclic loading, each specimen experienced 10 cycles of 200 N to 500 N axial load. This was followed by 10 cycles of torque between +8 Nm and -8 Nm superimposed on 200 N of static axial load. Following cyclic loading, each specimen was quasistatically loaded axially at 10 mm/min deformation rate until specimen failure.

Results: The polyaxial locking plate augmented with an intramedullary fibular strut graft showed the highest rigidity under cyclic torsional loading while the intramedullary nail had the lowest torsional rigidity. No differences were detected in the cyclic axial loading between the constructs. During quasistatic axial loading to failure, the intramedullary nail achieved the highest axial stiffness while the nonlocking plate showed the lowest. The polyaxial locking plate with strut graft displayed an axial stiffness lower than the intramedullary nail, but equal to the stiffness of polyaxial locking plate only or nonlocking plate.



Conclusion: This report is the first to examine fixation methods in a periprosthetic supracondylar fractures using an osteoporotic bone model. Based on the results, the polyaxial locking plate augmented with an intramedullary fibular strut graft yielded the highest torsional stiffness. The nonlocked plate showed the lowest strength and therefore should be avoided especially in comminuted fracture patterns.

See pages 47 - 108 for financial disclosure information.