Biomechanical Evaluation of Different Periprosthetic Femoral Fracture Fixations Using a Variable Angle Locked Periprosthetic Femur Plate System

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Disclosures:

Introduction:

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Methods:
Fifteen large adult synthetic left femora (4th Generation Composite Femur; Sawbones Worldwide, Vashon, Washington) were used. Each femur was implanted with a cementless hip prosthesis and osteotomized 45° to the shaft axis at the level of the implant tip to simulate a periprosthetic fracture, Vancouver type B1, OTA 32A2. A gap of 5 mm was created and fracture fixation was performed using a 12 hole periprosthetic proximal femur plate (NCB, Zimmer, Warsaw, IN). Bone samples were randomly assigned to one of the following Groups: 1. Proximal six 4 mm bicortical locked screws full contact. 2. Proximal 3 cerclages (Cable Assembly Cerclage, 1.8 mm). 3. Proximal cerclage (1+1 NCB Locking Plate Cable Button)/four unicortical 5 mm screw. Distally, all groups had three 4 mm bicortical screws. Testing was performed using an axial-torsional universal testing machine in three different loading modalities (axial compression to 500 N, lateral bending to 250 N, torsion to 200 N). After testing the samples for stiffness in all three modalities, cyclic loading was performed in axial compression with a maximum load of 500 N at three Hz for 10,000 cycles. After cyclic loading, the femurs were again tested in all three modalities. The specimens were finally loaded to failure in torsional loading. The failed samples were visually inspected for mode of failure.

Results:
None of the constructs failed during cyclic testing. No significant differences in stiffness were found in axial loading before and after the cyclic loading between the 3 groups. Flexural stiffness after cyclic loading was higher in group 1 (5.4 N/mm) compared to group 2 (4.5 N/mm) (p<0.01). Torsional stiffness for cable only constructs (group 3; 13.1 N/mm) was significantly lower compared with group 1 (17.2 N/mm) and 2 (15.7 N/mm) (p=0.01, p=0.03, respectively). Load to failure was comparable in group 1 and 3 (806 N, 818 N respectively) but significantly lower in group 2 (606 N, p=0.03). Differences were found in the type of failure. Constructs in groups 1 and 2 failed by trochanteric region fractures and loosening of the hip stem. One construct in group 1 fractured along two screw holes. In group 3 lateral displacement at the fractures occurred. Load to failure resulted in rupture of the proximal cables.

Discussion:
Modern periprosthetic plates offer a wide variety of fixation techniques. All fixation methods demonstrated stable fixation for axial loading. Differences were noted for flexion and torsion. Where
bicortical screw fixation is not achievable, cable fixation is recommended. Additional unicortical screws improve torsional stiffness for cable fixation.

**Significance:**
Modern periprosthetic plates offer a wide variety of fixation techniques, yet adequate stability is important for the orthopaedic surgeon. All fixation methods demonstrated stable fixation for axial loading. Differences were noted for flexion and torsion. Where bicortical screw fixation is not achievable, cable fixation is recommended. Additional unicortical screws improve torsional stiffness for cable fixation.

**Acknowledgments:**

**References:**

ORS 2014 Annual Meeting  
Poster No: 1068