A Biomechanical Analysis About Fixing the Locking Compression Plate of Distal Femur Fractures

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Purpose: The stable fixation of a distal femur fracture is essential for early joint motion and ambulation. A locking compression plate with the technique of minimal invasive plate osteosynthesis has been the most commonly used procedure in distal femur fractures. However, because of the pathoanatomical features of the patient and fracture characteristics, it is difficult to fix a sufficient number of screws at the distal part of the plate. This study aimed to identify how biomechanical stability varies according to the numbers of distal part screws of the LCP-DF (Locking Compression Plate-Distal Femur), which is a standard implant for distal femur fractures.

Methods: Biomechanical stability was compared between 3 LCP-DF fixation groups (3-screw group, 4-screw group, and 6-screw group). For each group, 6 synthetic adult-sized femur models (Model 3403, Pacific Research Laboratories) were used for the biomechanical research. The composite replicate femurs was used to simulate the distal femur fracture with comminution. After fixing the LCP-DF, the bone 6 cm and 8.5 cm above the distal edge of the knee part was removed with a gap of 2.5 cm. For the biomechanical analysis, the servo-hydraulic testing machine (MTS 810 Material Testing System) was used. For the cyclic loading, an axial loading of 100 N-1000 N, 3Hz, and 100,000 cycles was given, after a 100-N pre-load was given. For the failure test, an axial load at a velocity of 10 mm/min was given so that the load to failure, mode of failure, and displacement at load to failure were all recorded and analyzed.

Results: During the cyclic loading test, there was no failure in all of the 3-screw, 4-screw, and 6-screw groups. In load-to-failure test, average load to failure was 4214.8 N (range, 4138-4390) for the 3-screw group, 4273.2 N (range, 4143-4329) for 4-screw group, and 4713.3 N (range, 4587-4955) for the 6-screw group ($P = 0.007$). Every sample taken from the 3 groups showed cracks. The average displacement in the failure showed an average of 10.3 mm (range, 9.6-11.8) for the 3-screw group, 9.1 mm (range, 6.5-11.7) for the 4-screw group, and an average of 8.8 mm (range, 6.4-10.4) for the 6-screw group.

Conclusion: As expected, the 6-screw group was the strongest biomechanical construct of LCP-DF in the fixation of extra-articular distal femur fractures. However, in fractures with difficulty to fix 6 screws at the distal fracture segment, the fixation of 3 to 4 screws also achieved an acceptable stability.