Superior Fracture Fixation of Transverse Patellar Fractures with Wagon Wheel Construct Versus Anterior Tension Banding: A Biomechanical Cadaveric Study

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INTRODUCTION: Despite advancements in surgical technique, patellar fractures remain challenging to manage. Internal fixation of simple transverse patellar fractures is commonly performed using tension band wiring techniques, such as cannulated screw anterior tension band wiring (CATB). However, CATB is associated with high rates of symptomatic hardware, fixation failure, and reoperation. The wagon wheel (WW) construct is a novel transtendinous/transligamentous technique that involves circumferential mini-fragment plating with radially directed screws (Figure 1). A previously published case series demonstrated that the WW construct was associated with decreased rates of reoperation, symptomatic hardware, time to union, and gait aid dependences compared with CATB. However, no biomechanical study has compared these fixation strategies. Therefore, the goal of this study was to evaluate the biomechanical performance of the WW construct compared to CATB for fixation of simple patella fractures.

METHODS: Seven paired fresh-frozen human cadaveric lower extremities (n=14 knees) were utilized. All patellae were fractured using an oscillating saw to simulate two-part simple transverse AO/OTA 34-C1 patella fractures. Specimens then underwent paired randomization, with one knee allocated to surgical fixation with the WW technique and contralateral knee allocated to the CATB construct.All surgically fixed specimens underwent cyclic loading testing through 1000 cycles, as well as subsequent load-to-failure testing. Failure was defined as fracture displacement of ≥ 2 mm. Testing of all specimens was performed using a high-resolution optical motion tracking system that recorded fracture displacement in three dimensions throughout the testing duration (Figure 2).

RESULTS: The WW construct demonstrated less mean fracture displacement on the first flexion cycle (WW: 0.1 vs. CATB: 0.3 mm; p=0.055) and after 1000 cycles of flexion (WW: 0.31 vs. CATB: 1.0 mm; p=0.034), equating to 69% less mean fracture displacement than CATB (Figure 3). The mean force required to cause construct failure was more than double for knees fixed with the WW construct compared with CATB (900 vs. 434 N; p=0.011) (Figure 4).

DISCUSSION AND CONCLUSION: In the first human cadaveric biomechanical study to compare the novel WW construct to CATB, the WW construct demonstrated superior fixation stability and 69% less fracture displacement after 1000 cycles of flexion. The findings of this study provide biomechanical validation for previously reported clinical advantages of the peripheral plate-based WW construct, compared to CATB, demonstrating that the WW may offer superior fracture fixation stability through cyclic loading.