The Impact of Scaphoid Malunion on Carpal Kinematics: A Biomechanical Analysis

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Introduction: The clinical significance of scaphoid malunion is controversial as the biomechanical sequelae remains poorly understood. In this cadaveric study, the effect of increasing scaphoid malunion on carpal motion was assessed.

Purpose: To determine the kinematics of the scaphoid, lunate, capitate, trapezoid, and trapezium during unconstrained simulated wrist flexion/extension and to examine the effect of increasing simulated malunion on carpal bone kinematics.

Materials and Methods: Four (4) cadaveric upper extremities were tested in an active wrist simulator with loads applied to the wrist flexors/extensors (**Figure 1**). Scaphoid, lunate, capitate, trapezium, and trapezoid kinematics were captured using optical tracking and analyzed with respect to the radius. Each specimen was simulated in its native state to collect baseline data. Severities of malunion from 10°- 30° were simulated by creating a wedge osteotomy in the volar cortex of the scaphoid and fixating the resultant fragments using two Kirshner wires. The resultant motion paths where then recorded.

Results: There is a trend towards increasing lunate flexion associated with increasing scaphoid malunion.

Conclusion: In this interim sample study analysis there are secondary alterations to lunate motion that may signify carpal instability. Clinical significance of this motion alteration is yet to be elucidated, but this model serves as a basis for understanding the kinematic consequences of scaphoid humpback deformities.

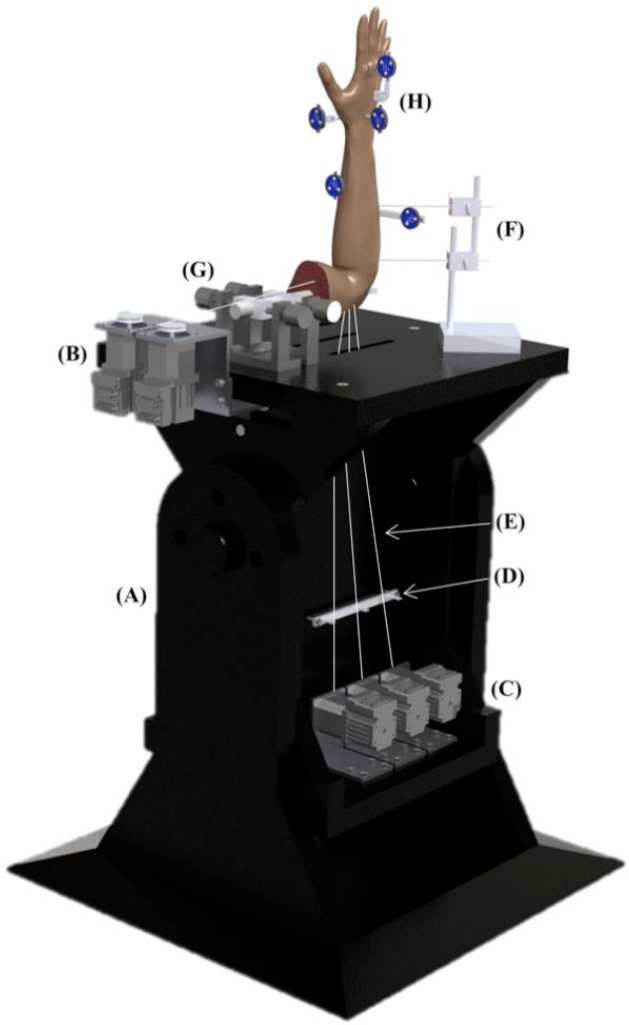

Figure 1: In Vitro Active Motion Simulator. This device is capable of loading the seven muscle groups of interest to simulate active wrist flexion-extension and radial-ulnar deviation: (A) simulator platform; (B) biceps brachii SmartMotor; (C) motor manifold used to control the magnitude of forces applied to the muscle group of interest; (D) cable guide rail used to converge the suture lines from the motor manifold the specimen; (E) suture cables connecting SmartMotors to the muscle group of interest; (F) ulnar support tower fixing the specimen at 90° of flexion; (G) humeral clamp rigidly fixing the specimen to the simulator; and (H) Optotrak six DOF tracking markers.