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Humeral Torque in Professional Baseball Pitchers and its Relationship to Humeral Shaft Fracture and the Development of Humeral Retrotorsion

Young Kyu Kim*, Michelle B. Sabick, Michael R. Torry, Richard J. Hawkins.
Dept. of Orthopedics Surgery, Gil Medical Center, Gachon Medical School
SteadmanHawkins Sports Medicine Foundation

Introduction

Spontaneous fractures of the humeral shaft have been reported during the throwing motion. These fractures are generally spiral in nature, suggesting they arise from torsion of the bone about its long axis. Because these fractures occur during the throwing motion, the forces generated during the throw are a likely cause. The large shoulder and elbow forces generated during the pitching motion have been well documented. However, the relationship between pitching biomechanics and torsional stress acting on the humerus has not been studied. The aims of the current study were to compare the torsional stresses acting on the humerus during the pitch to the torsional strength of the humerus and to explain the mechanism of humeral shaft fractures in throwers.

Methods

Two high-speed video cameras were used to videotape 25 professional pitchers competing in preseason games at 120 frames/s. The locations of 21 body landmarks were manually digitized in each camera and their three-dimensional locations were calculated using the Direct Linear Transformation method. Joint kinetics at the shoulder and elbow were computed using inverse dynamics. Internal forces and torques acting along or about anterior-posterior, medial-lateral, and distal-proximal axes of the shoulder and elbow were computed. The net humeral forces and torques were the difference between values at the proximal and distal ends, expressed in a humeral coordinate system. Kinetic date was normalized in time to facilitate comparisons among players.

Results

The mean age of the subjects was 26.8 2.9 years, and the mean pitch speed was 38.8 2.0

m/s (range 36.2 to 44.3). Maximum external rotation (MER) of the shoulder averaged 182 13 . The largest net force acting on the humerus was an axial force causing tension. The major force component acting on the humerus was a tensile force of 2091 345 N just prior to ball release when the shoulder internal rotation velocity was near its maximum. The predominant torque was an external rotation torque about the long axis of the humerus. This torque reached a mean value of 185 34 Nm and peaked near the time of maximum shoulder external rotation. The direction of the torque acting on the humerus was consistent with the proposed mechanisms of humeral shaft fractures and the development of humeral retrotorsion. This torque acted to rotate the proximal end of the humerus internally relative to the distal end throughout the majority of the pitching motion.

Implications

During the cocking phase of the pitch, there is an internal rotation torque at the shoulder while the forearm and hand are externally rotating, resulting in a twisting of the humerus about its shaft. The magnitude of the peak humeral torque, when compared with the torsional strength of the humerus, shows that there is a risk of humeral shaft fracture in every pitch. Such fractures are generally spiral in nature, suggesting shear failure of the bone due to the application of a large torsional stress. This data suggests that these fractures are most likely to occur near the time of maximum shoulder external rotation when humeral torque peaks.