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Wrist extensor tendon forces during tennis forehand are modulated by player-specific technique

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INTRODUCTION:
Lateral epicondylalgia, also known as tennis elbow, is a major health issue among tennis players, affecting hand extensor tendons and resulting in pain and impairments for everyday life. Unfortunately, prevention remains limited by the lack of data regarding biomechanical risk factors, especially hand tendon forces which evaluation remains challenging. Musculoskeletal modelling is a non-invasive method to estimate muscle and joint loading from motion capture data and already provided data for the upper limb joints [1,2] but was less used for the hand [3]. The objective of this study was thus to develop a musculoskeletal model to provide a new insight into hand tendon loadings in tennis players.
METHODS:
An Advanced player (ITN 3; grip strength: 653 N; eastern grip) and an Intermediate player (ITN 7; grip strength: 1195 N; semi-western grip) participated in a two-step protocol. First, players performed a series of grip force tasks to establish a relationship between electromyographic (EMG) activities and grip force. Second, players performed forehand drives, aiming a target with a ball at two shot speeds and with three rackets with different inertial properties.
Upper limb kinematics were tracked using reflective markers and a seven-camera motion capture system. EMG activities were synchronously recorded for four forearm muscles, including a finger extensor and a wrist extensor.
An EMG-informed musculoskeletal model was developed to estimate the tendon forces of 42 hand muscles. The model relied on an inverse-dynamics approach [3] with three main inputs: grip force estimated from EMG, wrist net moments deduced from marker data and four muscle forces estimated from EMG using force-length-activation relationships [4]. From the 42 tendon forces, muscle group forces of finger and wrist extensors were calculated by summing the forces of the four finger common extensor bellies and the three wrist extensors, respectively. Forces jut before impact were kept for further analysis.
RESULTS:
Finger extensors' forces were close to 50 N and negligible compared to wrist extensors' ones, ranging from 400 N to 750 N. Wrist extensor tendon forces increased with shot speed but were moderately affected by racket properties. After normalizing by grip strength and shot speed, wrist extensors' loading in the Advanced player were up to three times higher than for the Intermediate one, suggesting player-specific biomechanical strategies.
CONCLUSION:
The results of this study confirmed wrist extensors are exposed to high mechanical loadings and that player-specific characteristics, e.g., grip position, might modulate this loading. Further studies are required to clarify the individual factors influencing finger and wrist biomechanical loadings during tennis playing.
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