Biomechanics of Single Handed Backhand Stroke in Tennis Players

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Outlines

- Introduction

- Background
  - Force on the Hand
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Introduction

- Popular sport in the world
- More than 200 countries affiliated with the International Tennis Federation (ITF)
- Differences in biomechanics, equipment, and physical demands
- Unique profile of injuries from other racquets and throwing sports (Pluim, et al., 2006)
Introduction

- Develop effective measurements, determine the risk factors and other mechanisms to prevent injury (Rivara., 2003)
- Tennis is a sport that is unpredictable
- Complex physiological aspects of tennis play (Kovacs., 2006)
- Physical training with injury-prone movement patterns may lead to beneficial results (Baxter-Jones, et al., 1993; Lanese, et al., 1990)
Introduction

- Elbow problems occur at least once in 40% to 50% of players (George, et al., 2006)
- Tennis elbow: repeated impact, which results in shock and vibrations transferred to the wrist and elbow (Duane, et al., 1989; Ewald., 2007)
- Overuse of the wrist and finger extensor muscles (extensor carpi radialis brevis, extensor digitorum communis) (Ewald., 2007)
Introduction

- Less skill in the single handed backhand stroke tend to develop tennis elbow (Bauer, et al., 1999; Giangarra, et al., 1993; Morris, et al., 1989)
- No direct measurement of the biomechanics and postural control during single handed backhand stroke in tennis players
Significance for the Study

- Compare the differences between topspin and flat single-handed backhand stroke
- Understanding the mechanisms in tennis single handed backhand stroke
- Provide information for training program
- Correct the posture at single handed backhand stroke and reduce impact transmission to the forearm
- Prevent injury
Force on the Hand

- Force transmission depends on ball speed, speed of the racket, racket size, string stiffness, off-center impact, hand grip force, etc (Chow, et al., 1999; Hatze, 1976)
- Experienced tennis players produce higher impact at the racket but less impact at the elbow than the recreational players
- Experienced players transmitted lower racket impact than recreational players at wrist and elbow (Wei, et al., 2006)
<table>
<thead>
<tr>
<th>Phase</th>
<th>Experienced Group</th>
<th>Recreational Group</th>
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<tr>
<td></td>
<td>N</td>
<td>Mean</td>
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<tr>
<td>Racket peak acceleration, g</td>
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<tr>
<td>Wrist peak acceleration, g</td>
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<td>Elbow peak acceleration, g</td>
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<td>Elbow extensor EMG, MVC</td>
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</table>
Force on the Hand

- **Increase grip force**: greater impact magnitude, vibration time, and magnitude of the transmitted vibration (Brody., 1989; Hatze., 1992; Henning, et al., 1992)

- Ball rebound speed was not influenced by the magnitude of grip force (Ewald, 2007)

- **Reduced** grip forces could decrease the arm vibration loads, may prevent tennis elbow without decreasing ball velocity

- Handgrip control at the **follow through phase** is critical factor to reduce impact transmission to the elbow (Wei, et al., 2006)
Force on the Hand

- Novice player is subjected to greater stretch of the ECRB muscle than are advanced player
- Eccentric contraction of ECRB at ball impact exacerbated by wrist flexion and low muscle activation cause of repetitive microtrauma leading to injury in novice tennis players (Stephan, et al., 1999)
Fig. 1. EMG and wrist kinematics of novice and advanced players
Fig. 2. Muscle force in ECRB predicted by the model for advanced and novice groups. Raquet-ball impact is at time = 1.0 s (dashed vertical line).
Physiology of Tennis Performance

- High intensity, intermittent pattern, numerous of stretch-shortening cycle movements, and long match duration
- Total duration was usually 90–120 minutes on grass and fast surfaces, and 120–180 minutes on clay (Girard, et al., 2007)
- Real play time to rest time ratio was between 1:2 and 1:5
- Points had an average length of between three seconds on some of the faster surfaces to close to 15 seconds
Impact-loading activity was an effective strategy to improve bone health.

Dominant forearm were 6-7% larger than the opposite forearm in mean circumference.

Maximum voluntary contraction, in females the dominant hand was 25% stronger, and 18% stronger in male tennis players (Natasha, et al., 2007).
1. single-repetition maximum voluntary contraction
2. 30 consecutive repetitions
3. 30-s static hold
4. During the serve
Physiology of Tennis Performance

- Dominant forearm of male tennis players had a greater proportion of muscle and a smaller proportion of fat (Maughan, et al., 1986)
- Bone area, bone mineral content and density were increased in the dominant arm of tennis players (Gaële, et al., 2005)
- Impact was effective could be attributed to the repeated mechanical vibrations
Physiology of Tennis Performance

- **Spin** strokes had larger **torsional** loading than flat strokes.
- Torsional loading preferentially favors an increase in distal radius bone size.
- Asymmetry in distal radius cortical volume was **four times larger** in the one than in the two handed backhand players.
- One handed backhand technique had higher loads on the dominant forearm (Ducher, et al., 2005).
Elbow Problems in Tennis Players

- Prevalence rate varying from 14% (Gruchow, et al., 1979) to 41% (Priest, et al., 1980)
- Related to lateral extensor tendon overuse by eccentric contraction, failure of healing, and the torsional force mainly occurs in backhand strokes (Brian, et al., 2003)
- The risk factors of tennis elbow included older age, frequency of play, years of play, a lower playing technique, and heavier body weight (Ewald, 2007)
Novice players displayed the wrong kinematics and active pattern, use more elbow flexion and wrist ulnar deviation position.

Lead to greater stretch upon the elbow and wrist extensor tendons because the sudden muscle lengthening resulted from ball impact (Stephan, et al., 1999)
Elbow Problems in Tennis Players

- **Double-handed** backhand stroke difficult to develop poor mechanics
- There is a positive relationship between poor single-handed backhand stroke mechanics and developed tennis elbow (Charles, et al., 1993)
- **Off-center** ball impact on static racket resulted in nearly three fold greater vibration magnitudes than center impact (Ewald, 2007)
Thanks for your attention