Biomechanics of the forehand stroke

Original article: Bahamonde, R. (2001). *ITF CSSR*, 24, 6-8
Introduction

• The tennis forehand stroke has changed drastically over the last 10 years

• Today's players seldom use the traditional forehand but the modern topspin forehand stroke
Introduction

• Changes in the forehand technique have been attributed to:
  – New racket designs,
  – Better physical fitness of the players, and
  – Increasing speed of the game
Changes in racket designs

• Rackets are bigger, lighter, and stiffer than the traditional wooden rackets

• Allow players to hit the ball with:
  – More power and
  – More control
Changes in racket designs

• These changes in the forehand technique have influenced:
  – The type of grip,
  – Footwork, and
  – Racket backswing and forward swing
Preparation

The Grip

- Functions of the grip:
  - Provide the proper racket orientation at impact,
  - Place the wrist in a favorable strength position, and,
  - Allow for hand mobility
Preparation

The Grip

- Use a firm grip near impact to control the racket during off-centre hits

- Most tennis professionals advocate the use of a western or semi-western grip instead of the traditional eastern forehand grip
Preparation

The Grip

• Western:
  – Easier to generate topspin and maintain racket orientation at impact
  – Produce higher forward (toward the court) and sideways (along baseline) velocities than the Eastern
  – Difficult for players to hit low bouncing balls.
Preparation

The Grip

• Eastern forehand:
  – Greater wrist stability
  – Proper racket orientation at impact regardless of ball height

• Semi-Western forehand
Preparation

The stance

• Open stance:
  – Players must react faster and are forced to hit on the run due to the power developed in the groundstrokes and the serves
  – Little or no transfer of linear momentum since the step is taken side ways,
  – Only the segment rotations are used to generate power for the forward swing
Preparation

The stance

• Traditional square stance:
  – Takes longer to execute
  – It generates linear momentum; as the player steps forward toward the ball, and
  – Angular momentum; from the rotation of the legs, hips, and trunk
The backswing

Which type provides more racket velocity and control?

• Traditional straight:
  – Thought that provided more control
  – Loop (large and small) backswings provided greater racket velocity
The backswing

Which type provides more racket velocity and control?

• Large-loop:
  – Increases racket velocity, but affects racket control and timing

• Small-loop:
  – Increases racket velocity without affecting the timing and control of the stroke
The backswing

Which type provides more racket velocity and control?

- Regardless of the type of backswing used
- For more power and efficiency
- Transition between the backswing and forward swing:
  - Fluid motion: smooth and continuous
  - Enhances the player's ability to utilize the pre-stretching of the muscles
The forward swing

*Type*

- Modified by the changes in the game

- Multi-segment forehand technique:
  - Used by top professional players
  - Individual segments of the upper extremity are used to generate racket velocity
  - More compact arm during the backswing
  - Generate higher racket and ball velocities
The forward swing

**Type**

- Conventional / single unit forward swing:
  - Segments of the upper extremity move as a single unit from the shoulder
  - No differences in the grip or initial footwork
The forward swing

Type

- Select the forward swing:
  - Multi-segment or
  - single unit forehand

that best suits the player’s physical and motor skill abilities
The forward swing

*Racket trajectory and orientation*

- The trajectory of the racket (stroke arc):
  - Horizontal motion: flattened arc near impact
  - Vertical plane: Optimum angle of the racket $28^\circ$
The forward swing

*Racket trajectory and orientation*

- Angles:
  - Smaller tend to produce less spin
  - Larger sacrifice ball speed and the depth
  - Changes in footwork and forward swing influence the arc
The forward swing

*Racket trajectory and orientation*

- Multi-segment forehand swing:
  - Smaller arc = smaller swing radius = less accurate
  - Steep vertical trajectory at impact (47°)
The forward swing

*Racket trajectory and orientation*

• Open stance:
  – Not more efficient
  – Result of lack of preparation time for the forehand stroke
  – Less time to successfully hit the ball on the racket face in the horizontal plane.
The forward swing

*Racket trajectory and orientation*

- Closed stance:
  - More accurate racket path in the horizontal plane.
The forward swing

**Linear and Angular Momentum**

- How to develop more power and control?
- Both can be achieved through the proper development of linear and angular momentum
The forward swing

Linear and Angular Momentum

• Linear momentum:
  – Quantity of linear motion that a body possesses
  – Developed through the forces generated from the ground as you step forward and transfer your body weight from the back leg to the forward leg (for a closed stance footwork)
The forward swing
Linear and Angular Momentum

- Angular momentum:
  - Quantity of angular motion that a body possesses
  - Developed from the ground reaction forces (GRF)
  - Tends to produce a sequence of body rotations (legs, hips, trunk, upper limb, and racket)
  - Optimal trunk rotation is one of the outcomes of angular momentum
The forward swing

Linear and Angular Momentum

• Trunk rotation:
  – Correlated with racket velocity (about 10%)
  – Used in the pre-stretching of the shoulder muscles to allow them to produce a larger tension
Conclusion

What to do to produce explosive forehands?

• Understand the basic biomechanical principles
• Understand how to apply them to the different components of the strokes
Conclusion

What to do to produce explosive forehands?

• The racket is one of the most important sources of power for a tennis player
• Stress the importance of using trunk rotation and the legs throughout the forehand stroke
• Explain to the players the importance of a proper follow-through.