# WHAT TENNIS RESEARCH TELLS US ABOUT... BIOMECHANICS OF GROUNDSTROKES

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A series of articles on the biomechanics of groundstrokes which have appeared in sport scientific publications are summarised below. Coaches interested in obtaining more information from these articles can find them using the relevant references.

## WRIST KINEMATICS IN THE BACKHAND STROKE

In this study the authors investigated the wrist kinematics (flexion/extension), grip pressures and wrist muscle electromyographic (EMG) activity in novice and expert tennis players performing the backhand stroke. Results showed that: expert players hit the backhand with the wrist extended (neutral alignment of the forearm and hand dorsum) and that their wrist was moving into extension at impact. In contrast, novice players struck the ball with the wrist more flexed while moving their wrist further into flexion. Expert players also displayed greater wrist extension in the follow through. Novice players eccentrically contracted their wrist extensor muscles during impact which may contribute to lateral tennis elbow.

*Blackwell, J. R.. & Cole, K.J. (1994). Wrist kinematics differ in expert and novice tennis players performing the backhand stroke: implications for tennis elbow.* **Journal of Biomechanics**, 27, 5, 509-516.

## ACCURACY IN THE FOREHAND DRIVE: CINEMATOGRAPHIC ANALYSIS

The study was designed to determine the method or methods used by highly skilled right handed players to direct the ball to the right (down the line) and to the left (cross court). The measurements made included drive direction, racket angle, wrist angle, forearm line, elbow angle, shoulder angle, foot direction, step direction and ball-body relationships. The results showed that:

a) Racket angles at impact for right drives were closer (72°-80°) than for left drives (93°-102°).

b) Balls hit to the left were contacted earlier in their flight towards the player than balls directed towards the right.

c) Balls hit to the right were contacted approximately opposite the right shoulder while balls hit to the left were contacted before the ball reached the left shoulder.

d) Players pointed the foot more towards the center of the net (180°) for balls hit to the left than for balls hit to the right.

*Blievernicht, J.G. (1966). Accuracy in the tennis forehand drive: cinematographic analysis.* **Research Quarterly**, 39, 3, 776-779.

## THE TOPSPIN BACKHAND DRIVE IN TENNIS: A BIOMECHANICAL ANALYSIS

Three-dimensional high speed photography was used to record stationary down the line, cross court and running down the line backhand drives of elite tennis players. Results showed that:

a) No significant differences were recorded in the three different backhands at the completion of the backswing phase.

b) At impact, a smaller shoulder joint angle, a more acute shoulder alignment, a larger wrist angle and a racket inclined further forward was recorded for cross court backhands when compared to down the line ones.

c) The running backhand reported a more vertical trunk at impact when compared to the two stationary strokes.

*Elliott, B.C., Marsh, A. P. & Overheu, P.R. (1989). The topspin backhand drive in tennis: A biomechanical analysis.* **Journal of Human movement**, 16, 1-16.

## THE MECHANICS OF THE LENDL AND CONVENTIONAL TENNIS FOREHANDS: A COACH'S PERSPECTIVE

High speed photography was used to record stationary down the line, cross court and running down the line forehand drives of elite tennis players. Results showed that:

a) The strokes began with flexion of the knees and hips accelerating the body down towards the court. Deceleration of the body then applied stretch to the muscles which resulted in the subsequent storage of elastic energy in muscles.

b) This stored energy was then partially used to assist the lower limb drive in moving the player to the ball.

c) The players then stepped towards the sideline with the back foot such that it landed parallel with the baseline.

d) This was followed by a step to the ball with the front limb creating a semi-open stance at impact which allowed full rotation of the hips and shoulders as well as forward weight transfer.

e) Players used two methods of backswing:

   1) conventional one (moving the racket back in synchrony with the shoulder turn and rotating the whole racket limb about the shoulder), and

   2) leading with the elbow (rotating the forearm and racket about the elbow)

f) Irrespective of the type of backswing used, it was characterised by a loop in all forehands which produces a more fluent stroke and allows the racket to accelerate over a larger distance.

g) The position of the racket at the completion of the backswing was similar for the two styles of backswing.

h) At the end of the backswing the racket was taken further back than the often recommended "pointed at the back fence" position which increases the length of the forward swing and provides greater distance over which to accelerate the racket.

i) At the commencement of the forward swing the racket dropped to a position below the level of the approaching ball.

j) Both knees and hip extension raise the hitting shoulder and assist the low to high racket trajectory.

k) Rotation of the trunk and low limb drive increased racket velocity.

l) The elbow joint extended during the early forward swing, but prior to impact it began to flex.

m) Racket velocity is higher just before impact than at impact, and "leading with the elbow" forehands produced higher racket and ball velocities than "Conventional" ones.

*Elliott, B.C., Marsh, A. P. & Overheu, P.R. (1987). The mechanics of the Lendl and conventional tennis forehands: A coach's perspective.* **Sports Coach**, October-December, 4-8. Also in *Elliott, B.C., Marsh, A. P. & Overheu, P.R.* (1989). *A Biomechanical comparison of the Multisegment and single unit topspin forehand drives in tennis.* **International Journal of Sport Biomechanics**, 5, 350-364.

## THE SLICE BACKHAND IN TENNIS

High speed photography was used to record slice backhand drives of right handed elite tennis players. Results showed that:

a) Players used Eastern Backhand or Continental grips, although they were also able to hit using the "wrist behind the handle" grip.

b) The shot began with the flexion of the knees and hips, and the "unit turn" (pivot of the left foot, backward movement of the racket and trunk rotation).

c) For the high slice backhand, the initial flexion of the knees was not so evident.

d) During the backswing the players used their free-hand to assist the backward movement of the racket in two ways:

   1) Racket-hand is taken back in an almost straight line and then lifted to shoulder height

   2) Hand is almost immediately lifted to shoulder height in a more looped backswing. This second technique is considered as the preferred one in preparation for the slice backhand.

e) Then players stepped toward the ball and adopted a closed stance more for low than for high bouncing slice backhands.

f) At the completion of the backswing the racket was above the level of the shoulders.

g) Players, with respect to trunk rotation, prepare for slice and topspin backhands in a similar manner.

h) Racket was rotated so that it was almost parallel with the back fence in both impact situations.

i) Players approached the high bouncing ball with a flatter trajectory than occurred for the lower impact.

j) At impact, the racket face was more open for the lower stroke than for the higher one.

k) As the impact height increases, coaches should emphasise a lesser downward trajectory and a more vertical racket face.

l) In the slice backhand, the ball is impacted closer to the body than in the topspin or flat backhand.

m) The elbow joint is not fully extended at impact as this will increase the potential for injury.

n) The weight is predominantly on the front limb at impact and the trunk is leaning in the direction of the net.

o) The trunk is stable at impact for both high and low slice backhands.

p) Forward rotation of the upper arm followed by extension of the forearm at the elbow joint are the key movements during the backhand forward swing.

*Elliott, B.C., & Christmass, M. (1993). The slice backhand in tennis.* **Sports Coach**, July-September, 16-20.

## TEACHING ONE AND TWO HANDED BACKHAND DRIVES

The purpose of this investigation was to study the backhand of 36 highly skilled female tennis players. The results showed that:

a) The one-handed backhand is basically a multiple-segment motion in which the hips, trunk, arm, forearm, and hand and racket move in an extremely co-ordinated fashion.

b) The two-handed backhand was observed to be a two-segment motion where hips rotate, then the trunk and upper limbs rotate simultaneously.

c) It was suggested that the multiple-segment co-ordination required by the one-handed backhand may explain why many beginners "lead the swing with their elbow" or "drop the hand and racket" just prior to impact to help propel the ball upward.

*Groppel, J.L. (1983). Teaching one and two handed backhand drives.* ***JOPERD*** n°38.23- 26.

### Other articles on this topic

Elliott, B.C., Takahashi, K., Noffal, G..J. (1997). The influence of grip position on upper limb contributions to racket head velocity in a tennis forehand. **Journal of Applied Biomechanics**, 13, 182-196.