WHAT TENNIS RESEARCH TELLS US ABOUT . . . BIOMECHANICS OF VOLLEYS AND APPROACH SHOTS

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A series of articles on the biomechanics of volleys and approach shots 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.

ANALYSIS OF TENNIS VOLLEY TECHNIQUES

The purpose of this study was to analyse the techniques of the volley of professional players. Five professional players took part in the research. Results showed that:

a) The power in the stroke came from the legs thrusting the body forward, the turning of the shoulders and extension of the forearm at the elbow, or the power came from the movement of the upper limb as a unit from the shoulder.

b) No decision was possible to identify a single-volley technique based on the five professional players filmed.

Turner, J.M. (1966). An analysis of tennis volley techniques. **Unpublished Master's thesis.** *San Diego State College. San Diego, California.*

A KINEMATIC AND KINETIC ANALYSIS OF THE TENNIS VOLLEY IN 12-15 YEAR OLD CHILDREN

In this study the authors investigated the characteristics of the volley in intermediate and advanced tennis players. The subjects in this study were chosen from a year-round junior development and training programme. Five subjects were filmed from the advanced group and five subjects from the intermediate groups. Standard biomechanical procedures were used to digitize 13 body segments and kinetic energy analysis was accomplished through appropriate computer software. Results showed that: advanced players produced a great amount of kinetic energy and greater segmental velocity measures while using a shorter swing than the intermediate players. The advanced players also tended to use a Continental grip while the intermediate players tended to use an Eastern forehand grip.

Roetert, E. P. & Garrett, G.E. (1987). A kinematic and kinetic analysis of the *tennis volley in 12-15 year old children.* **Proceedings of the XI International Congress of Biomechanics**, *267. Free University Press. Amsterdam.*

THE MECHANICS OF THE PUNCH VERSUS THE DRIVE VOLLEY FOR SKILLED PLAYERS

The study was designed to analyse the mechanics of the punch versus the drive volley for skilled competitors. High-speed films were taken as these players attempted either punch or drive volleys towards a specific target located near the baseline. The results showed that the skilled players were more accurate with the punch volley than they were with the drive volley.

It was concluded that although more force can be created with the drive volley by increasing the range of motion of the upper limb and racquet head, accuracy is lost in creating more force.

Kernodle, M., Groppel, J.L., & Campbell, K. (1982). A kinematic analysis of the forehand drive volley. In J.Groppel (Ed.) **Proceedings of the Fourth International symposium on the effective teaching of racquet sports**, *Champaign, Il. University of Illinois Conferences and Institutes.*

MUSCLE ACTIONS AND GROUND REACTION FORCES IN THE FOREHAND VOLLEY

This study investigates the action of nine muscles during the execution of the volley. The purpose of the research was to determine which muscles are active and in what sequence and to what extent they participate in the execution of the volley. Besides muscle action it was informative to know the overall force action of the human body during the volley. Muscles studied were the following: Flexor pollicis brevis, Brachioradialis, Deltoideus, Triceps, Pronator teres, Pectoralis major, Biceps brachii, Latissimus dorsi and infraspinatus. Results showed that:

a) During the acceleration phase all nine muscles exhibit a strong activity with the exception of the M.Triceps Brachii and M. Brachioradialis.

b) This would indicate that there is less elbow flexion during a volley when compared to a forehand groundstroke.

c) This is reasonable since during a volley there is less swing of the arm, therefore putting less demand on the elbow flexors.

d) The anterior part of the M.Deltoideus shows strong activity for the whole of the volley.

e) This is not the case for the M.Pectoralis major, the alternative anteflexor, during ball impact and follow through, where only minimal action is displayed.

f) When comparing the muscle activity between the forehand groundstroke and the forehand volley, data has shown that the volley (generally assumed to require less forceful muscle action than the forehand) still demands strong muscular effort in order to be executed properly, except for the elbow flexors.

g) The force patterns for the forehand volleys are not very consistent. There are wide variations within and between players. For the players in this study the volley does not exhibit any characteristic force pattern. However, it was found that the ground reaction forces were relatively low. The upward thrust was observed to be the strongest, but it did not surpass one-third of the body weight.

Van Gheluwe, B. & Hebbelinck, M. (1986). Muscle actions and ground reaction forces in tennis. **International Journal of Sport Biomechanics**, *2, 88-99.*

THE MECHANICS OF THE VOLLEY: A CINEMATOGRAPHIC ANALYSIS

High speed photography was used to record forehand and backhand volleys of both advanced and intermediate tennis players. The study also compared volleys hit at the service line and closer to the net. Results showed that:

a) The length of the backswing varies for volleys hit at the service line compared to those closer to the net.

b) The racket was positioned behind the hitting-shoulder for volleys played at the service line by high level players, while in volleys played closer to the net the racket was relatively closer to the shoulder.

c) The racket was logically always displaced further behind the body for backhand volleys than for forehand volleys.

d) Advanced players recorded greater wrist and tip of racket velocitites when compared to the intermediate group.

e) The advanced players moved their racket forward and downward after impact while the intermediate players moved their racket using an action where the racket face opened and moved more in a downward trajectory.

f) It was showed that the racket has to move in the direction of the hit for an effective volley.

Elliott, B.C., Overheu, P.R. & Marsh, A. P. (1988). The service line and net volley in tennis: a cinematographic analysis. **Australian Journal of Science and Medicine in Sport**, *20, 10-18.*

THE FOREHAND APPROACH SHOT IN TENNIS

High speed photography was used to record forehand approach shots of elite tennis players. The purpose of the study was to compare the characteristics of the topspin and the backspin approach shots. Results showed that:

a) The mechanics of the topspin and backspin forehand approach shots are significantly different.

b) Players used a variation of grips that lay between an Eastern forehand and a Semi-Western. No players changed their topspin grip to a Continental grip to hit their backspin shot. However, all players were able to align their racket with the ball at impact by re-adjusting the grip.

c) A similar method of preparation was used initially for both shots in that the players ran to the vicinity of impact while turning the body and the feet so that they were perpendicular to the line of flight of the ball.

d) A variety of backswing techniques (rotation about the elbow or looped backswing) were used to take the racket back in both strokes.

e) A more continuous movement occurred in the topspin stroke with the racket past a line drawn perpendicular to the back fence as the backswing flowed into the forward swing.

f) A reduced backswing is needed compared to the regular forehand groundstroke.

g) The backspin was characterised by a reduced backswing when compared to the one used in the topspin.

h) An increased trunk rotation and smaller shoulder angle caused by the hitting limb being positioned closer to and more behind the body were two further characteristics of the preparation for the topspin forehand approach when compared to the backspin.

i) The forward swing of the racket was preceded by the forward movement of the left foot towards the ball in both strokes so that a semi-open stance was adopted for impact.

j) The velocity of the hip remained relatively constant through the forward swing and follow through. Values show that while a stable and yet dynamic base was needed for impact, it was important to keep moving towards the net in an approach shot especially in the topspin shot.

k) The individual segments play more of an individual role in the topspin approach shot (elbow flexion is needed to produce the required racket velocity and trajectory), while the backspin shot is more characterised by the upper limb moving forward as a single unit.

l) A low-to-high trajectory was recorded for topspin strokes while in the backspin the racket moved in a downwards path.

m) During impact, the body moved down in the backspin shot. A lower body position at impact is needed in the backspin shot when compared to the topspin.

n) At impact the racket was kept a comfortable distance from the trunk. The upper limb was near full extension and the wrist was laid back at impact irrespective of the type of approach shot played.

o) The topspin shot was hit further forward than the backspin one. The angle of the racket face at impact was 6º open for the backspin shot and 7º closed for the topspin one.

p) The racket velocity was higher in the topspin shot than in the backspin one.

q) In the follow through of the backspin shot the racket moved downwards and then upwards prior to adopting a position in front of the body ready for the ensuing shot.

r) In the follow through of the topspin shot the racket moved upwards and finished above the left shoulder.

s) The topspin shot approached the court at a steeper angle and rebounded at a steeper angle than the backspin stroke. The data supports the common belief that the backspan approach shot "keeps low" while the topspin shot "rises" after bouncing.

t) The higher post-impact ball velocity of the topspin shot means that the opponent will have less time to cover this stroke than the backspin shot that is hit with a significantly lower velocity.

Elliott, B.C., & Marsh, T. (1990). The forehand approach shot in tennis: a coach's perspective. **Sports Coach**, *July-September, 11-15.*