UNDERSTANDING SPEED IMPROVEMENT FOR TENNIS

Dr. George B. Dintiman, President
National Association of Speed and Explosion (naseinc.com)

Very few professional tennis tournaments take place without a team of TV commentators (former players, coaches) discussing and analyzing the court speed and quickness of individual male and female players. Comments reveal a considerable amount of misunderstanding and even myth concerning exactly how players improve their speed of movement on the court. Some coaches and players have totally different views; others are just not sure exactly where to focus for optimum results. Suggested training programs may be limited to on-court drills and neglect key physical training aspects that bring about the tissue changes needed to improve on-court starting and acceleration speed. Others may avoid speed training entirely and operate under the pretense that speed and quickness is a God-given talent and cannot be altered. The truth is that tennis-specific speed training is uncomplicated, highly effective, and easily incorporated into existing training schedules.

At the risk of oversimplifying a holistic approach, this article focuses on six general concepts designed to increase the understanding and application of speed training for tennis. Every player can improve on-court speed and quickness regardless of genetic make-up and the presence or absence of fast twitch muscle fiber. “Heredity deals the cards but environment plays the hand” and the only way a player can reach maximum tennis playing speed potential is to engage in a sound training program that applies each of the concepts discussed below.

Everyone is aware that tennis singles requires continual short bursts of speed forward, backward, diagonally, and left and right every game of each set. Coaches do a superb job of teaching players to obtain an early read on the direction, spin, and speed of the ball and mastering the correct footwork for rapid stopping, starting, and movement in all directions. Tennis specific drills establish on-court movement patterns that help players arrive to the ball sooner, however, drills do not bring about the physiological changes necessary to increase starting and early acceleration speed. To be effective, a program must apply the concepts below focusing on the main objective of increasing the speed and distance covered in the first three steps and early acceleration (5-15 Yards).

1. Speed of movement is improved by applying more force to the ground. The amount of ground contact force that can be delivered with each stride is the most important factor in determining the speed of the first two steps and rapid early acceleration on the tennis court.

Tennis players should strive to become the strongest possible person in the leanest body. For every pound of body weight, approximately 2.1 pounds of ground contact force (the pushing action away from the ground with each step) is needed to overcome the force of gravity and propel the body upward and forward during a short sprint.
If an athlete gains 10 pounds (muscle or fat), an additional 21 pounds of force against the ground with each step is needed just to maintain the pre weight-gain speed. (10 lb. X 2.1 = 21). Unless weight gain is accompanied by an increase in ground contact force, slowing will occur. A 10-30 pound weight loss (Marty Fish, Svetlana Kuznnetsova, and others) has the opposite effect and, even though ground contact force (GCF) does not increase, the same force applied to the ground will propel the lighter mass forward faster (steps-per-second) and further (long stride) and improve speed in a short sprints. Losing excess body weight AND also increasing ground contact force, will produce the greatest improvement in a short sprint.

Although this ground force application and ratio of body mass/ground contact force is key during all phases of a sprint, it is even more critical during the start (first two steps) and early acceleration when much greater force is needed to propel the body upward and forward from a stationary position.

The main objective is to increase the speed-strength of the hip flexor muscles involved in the pushing action against the ground. As famed track coach, Tom Tellez points out, “the hip acts as a crank to deliver the force to the ground and the athlete who can best utilizes the hip joints will be more successful in sprinting.” Studies have shown that a 12.2% increase in hip flexor strength improved 40-yd dash times and shuttle run times by 3.8% and 9.0% (Effects of hip flexor training on sprint, shuttle run, and vertical jump performance. Journal of Strength & Conditioning Research. 19: 3: 3: 615-621, August 2005). A correlation has also been found between psoas muscle strength, the main hip flexor, and 20, 50, and 100 meter times (Influence of the psoas major and thigh muscularity on 100-m times in junior sprinters. Med Sci Sports Exerc. 2006 Dec; 38:12:2138- 43). The association was the strongest for the shorter distance of 20- meters.

2. Training programs to improve ground contact force for tennis players should strive to add speed-strength with minimum muscle hypertrophy and weight gain.

The objective of strength training is to increase GCF without adding body weight in the form of fat and only a limited amount of muscle weight. Although a slight weight gain may occur due to some muscle hypertrophy, speed-strength increases more than counteract the weight gain by providing a “bigger engine” and additional pushing force. In tennis, where body weight and muscle mass are less important than in sports such as football, rugby, lacrosse, and basketball, weight training programs are designed to add speed-strength with minimum muscle hypertrophy and minimum weight gain. This type of program favorably alters one-half of the body weight/ground contact ratio by increasing ground contact force without increasing the force to be moved (body weight).

The training programs to accomplish this objective are speed-strength training in the weight room, plyometrics (weight room and outdoors), and sprint-resisted training using the Austin Leg Drive Machine®, heavy sleds, heavy resistance cords, weighted vests and body suits, and staircase and uphill sprinting. These programs increase the amount of effective force delivered at ground contact.

Table 1 points out the differences between strength training programs designed to add muscle weight and those attempting to increase GCF by adding speed-strength without gains in body weight. The minimum hypertrophy (growth) program increases GCF without adding body weight. The maximum hypertrophy program is not only less effective in increasing GCF, it also adds body weight, thus increasing the amount of force required to propel the body upward and forward.

Coaches should also make certain that both feet are exerting maximum and similar force against the ground during the pushing action. Speed-strength imbalances between the right and left leg and foot reduce overall driving force and negatively affect sprinting form and speed. Muscle imbalances can be identified in the weight room with 1RM testing (maximum amount of weight that can be performed for one repetition) using the single leg press, single leg curl, single kick back exercise, and the stride length test comparing one stride after a left-foot push-off to one stride after a right foot push-off.
### Table 1 Comparison of Minimum and Maximum Hypertrophy Speed-Strength Training Programs

<table>
<thead>
<tr>
<th>TRAINING VARIABLES</th>
<th>MINIMUM HYPERTROPHY (Minimum mass &amp; weight gain)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Intensity (Load/Weight)</td>
<td>90-100% of 1 RM</td>
<td>70-80% of 1 RM</td>
</tr>
<tr>
<td>Volume (Reps/Sets)</td>
<td>1-5 repetitions, 1-5 sets</td>
<td>8-12 repetitions, 3-4 sets</td>
</tr>
<tr>
<td>Rest Interval (Between Sets)</td>
<td>5 minutes</td>
<td>1 minute or less</td>
</tr>
<tr>
<td>Speed of Completion</td>
<td>Explosive through the range of motion: slower on negative return.</td>
<td>Less emphasis on explosive movement.</td>
</tr>
<tr>
<td>Exercises</td>
<td>Weight Training: Dead lift, kickback, ankle press, and numerous exercises in both a horizontal and vertical direction that mimic the mechanical position and angle when executing the first 3-5 steps on the tennis court. Resistance Training: Austin Leg Drive Machine, sleds, incline sprinting, modified sprint-resisted training. Plyometrics: Movements simulate the movement patterns that occur during the first 3-5 steps of a short sprint in tennis.</td>
<td>Numerous upper and lower body exercises stressing full body development. Use of periodization, changing the selection and order of exercises. Super-sets, compound sets, use of a 4 or 6-day split routine, and variations of the above.</td>
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3. The speed with which ground contact force can be applied affects horizontal and vertical velocity at all distances.

The findings of Weyand and others (“The biological limits to running speed are imposed from the ground up,” by Weyand, Sandell, and Bundle, *Journal of Applied Physiology*, April 2010 vol. 108 no. 4 950-961) suggest that the biological limits of maximum speed may be increased from the current 28 mph achieved by Usain Bolt to 35 mph or more. Studies show that the limbs are capable of applying much greater force to the ground during the pushing action each step. Researchers feel that the limiting factor evolves around the brief periods of time available to apply vertical force to the ground. Elite sprinters apply these forces in less than 1/10 of a second with peak ground contact forces occurring within less than 1/20 of a second of the first instant of foot-ground contact.

During ground contact at maximum velocity, 25% is spent applying force to the ground and 75% is spent trying to get the foot off the ground. Obviously, a reduction in ground contact time with each stride will increase speed of movement. If a 10.20 100-meter sprinter reduces ground contact time by 0.01 seconds, the 45 strides in the 100-meter dash can reduce the time to 9.75 seconds by shaving off 0.45 seconds (Ralph Mann, *The Mechanics of Sprinting and Hurdling*, ©2007). The fastest athletes in tennis...
apply more force to the ground within the least amount of time and, in combination with correct form and
technique, deliver this force in the proper direction to increase stride rate, stride length, and speed. Elite
sprinters develop an optimal or slightly above average stride length, then focus on improving
performance by increase their stride rate.

Researchers feel that there is a biological limit to how quickly muscle fibers are capable of generating the
vertical force needed to get the runner back up off the ground each step (Matthew Bundle, Assistant
Professor of Biomechanics, University of Wyoming). Limits appear to be controlled by the contractile
speed limits of muscle fibers. Muscle contractile speeds that would allow near maximum force would
support running speeds of 35-40 miles per hour.

4. Neuromuscular training can increase the number of strides an athlete can take per second.

Although more research is needed, existing findings indicate that neuromuscular training in the form of
sprint-assisted training is effective in increasing stride rate and speed of movement in short sprints.
Researchers are now examining the exact effect of this type of training on ground contact time. Techniques
such as towing with surgical tubing, the Ultra Speed Pacer, and the Sprint Master® have revealed significant improvement in 40-yard and 50-yard dash times. Studies at Virginia Commonwealth
University in the 70's and 80's revealed significant improvement in short sprints following 8-12 week
training programs consisting of towing with surgical tubing and the Sprint Master® and the use of a high
speed treadmill.

5. Proper footwork and correct starting, stopping, and sprinting form is necessary
to deliver maximum power (ground contact force) with all forces applied in the right
direction.

Since tennis coaches are so effective in training players to obtain an early read on the direction, speed,
and spin of an opponent’s stroke and in executing proper footwork for rapid starting, stopping, and
acceleration, correcting a few other form errors noticeable in tennis is an easier task.

Some players bend a bit too much at the waist when sprinting forward which actually reduces
acceleration speed. Proper “lean” enhances the “drive” phase of a short sprint and occurs in a straight
line from the ankles through the ear with very little bending at the waist. Even Olympic sprinters who
begin the 100-meter dash in a 4-point stance bend very little at the trunk. The lean occurs from the ankle
through the ear in a straight line.

Players may also be told to “run on their toes” although the toes are not capable of generating much force
since the power comes from the balls of the feet. During the support phase, the foot makes initial contact
with the ground on the outside edge of the ball of the foot. The weight of the body is then supported at a
point that varies according to speed. The faster the speed, the higher the contact point on the ball of the
foot. Striking the ground first with this part of the foot serves to maximize speed but takes great energy. At
slower speeds (jogging, for example), the contact point moves toward the rear of the foot between the
arch and heel. Even during sprinting, the heel makes a brief but definite contact with the ground. It is
impossible to reach maximum speed by running on the toes. There are a number of other areas such as
tension, relaxation, arm movement, and foot placement that track coaches can correct in tennis players.
Seeking the help of a track coach is often a wise decision.

6. The combination of regular on-court play and interval sprint training is needed to
develop a high level of speed endurance.

Depending upon the style of play, a point may last from 5-10 seconds to 30 seconds or more. The goal of
all tennis players is to able to complete a high number of repeated short sprints each game throughout
the match with little or no slowing due to lactic acid buildup and fatigue. Coaches place the main training
emphasis on rapid recovery between sprints rather than training to prevent slowing at the end of a long
A sprint. A solid aerobic base also plays a part by expediting recovery during rest between points, games, and sets and extending the anaerobic threshold or point at which lactic acid accumulation begins.

No type of training is more sport-specific than actual singles play in tennis which forms the foundation of speed endurance (anaerobic) conditioning. On-court interval sprint training or similar training on various surfaces is also recommend using repetitions of 5-10 yards with very limited rest between each (1-3 seconds on sprints up to 10 yards) and 25 seconds, the time permitted between points, on longer sprints of 11-20 yards when using over distance training). Careful record keeping (repetitions, distance covered, total volume, recovery or rest interval) is necessary to insure progression and improvement from one workout to another.

**SUMMARY**

Tennis coaches provide an excellent speed improvement foundation to players by developing superior footwork for multidirectional movement. The next step is the key to improved starting and early acceleration speed for tennis and involves building on this foundation using training programs designed to increase ground contact force, increase the speed with which this force is applied, and correct errors in form and technique to make certain these forces are being applied in the right direction. Sound speed-endurance (anaerobic) training then assures that players will start and accelerate at the same high speed throughout the match with little slowing due to fatigue.