FUNCTIONAL REHABILITATION

A Core Stabilization Training Program for Tennis Athletes

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The core includes the lumbopelvic-hip joint complex and its surrounding musculature, which function synergistically to produce force, reduce force, and provide dynamic stabilization throughout the kinetic chain. The quality of these actions during functional movements requires optimal neuromuscular efficiency and control. Mechanoreceptors provide the central nervous system with proprioceptive feedback necessary to maintain normal length-tension relationships in muscles (neuromuscular activation pattern), which create force couples that act through the osteoligamentous elements of the spine (inner core musculature activated prior to outer core musculature). This facilitates maintenance of optimal arthrokinematics in the lumbopelvic-hip complex during functional kinetic chain movements, optimal neuromuscular efficiency throughout the entire kinetic chain, optimal acceleration and deceleration, dynamic stabilization of entire kinetic chain during functional movements, and proximal stability for efficient lower extremity movements.

Core stabilization is an essential component of any athlete’s total fitness, but it may be particularly important for tennis players. Tennis is not a one-dimensional game; players are constantly shifting their bodies from side to side or rotating their bodies toward the ball. One aspect of tennis strategy requires the player to keep the opponent running and off-balance, hence making many directional changes during a match. Core strengthening and stabilization training helps to increase functional strength and dynamic balance, thereby promoting tennis performance.

The purpose of this report is to outline a core stabilization program that is specific to tennis.

Development of a Core Stabilization Program

Because there is no universally-accepted program for promotion of core stabilization, optimal exercises and training parameters that should be used are unknown. According to McGill, a justifiable approach to enhancement of lumbar stability involves abdominal co-contraction and muscular bracing in a functional manner. Brandon adds that core stability training should be conducted in a manner that effectively recruits the trunk musculature, while maintaining control of the lumbar spine during dynamic movements. Gambetta has suggested that the more the training environment replicates the functional demands of a particular sport, the more versatile the athlete will be in handling the stresses imposed by the actual sport activity. Exercises should be focused on motor control, with emphasis on neutral spine posture and contraction of the transverse abdominus, multifidus, and pelvic floor muscles. The exercises should be initially performed with low-level tonic contractions and gradually progressed to co-contraction of the entire core musculature during performance of functional tasks.

Traditional rehabilitation focuses on absolute strength gains in isolated muscles and in a single plane of motion. Because functional sports movements...
are multidirectional, athletes need to strengthen hip
and trunk muscles to provide dynamic stability in all
three planes of motion. Clark et al. proposes that
all functional activities are triplanar, which require
specific muscle activation patterns for acceleration,
deceleration, and dynamic stability. A uniplanar move-
ment also requires dynamic stabilization of the kinetic
chain to retrain extraneous movements in the other
planes for optimal neuromuscular efficiency. Pelvic
positioning, rib cage positioning, and proper patterns
of neuromuscular recruitment should be addressed by
a core stabilization program.

The body mechanics and performance strategies
utilized in tennis are widely known. The available
research pertaining to optimal methods for core stabi-
lization training of tennis players, however, is minimal.
Only one study has supported the use of a specific core
stabilization program for athletes. Swaney and Hess
reported beneficial effects on the posture of swimmers
after completing a nine-week core stabilization train-
ing program, implemented two times per week using
the National Academy of Sports Medicine’s standard
core stabilization exercises. Jeffreys has suggested a
systematic progressive approach to the introduction of
core stabilization exercises in athletes. Based on the
techniques of Swaney and Hess and those of Jeffreys, a
core stabilization program for tennis players has been
created by the authors. Although these exercises are
believed to produce the desired effect of improved core
stabilization, the degree of program effectiveness has
not been systematically evaluated.

Exercise Selection

A systematic literature review was performed for
exercise selection, with the inclusion criteria specified
as any type of study that used the key words of core,
stabilization, and/or strengthening. A general protocol
was derived from consistent findings of the reviewed
studies, while using Jeffreys categorization
of progressive core exercises as a guide in exercise
selection. Five exercise program levels consist of (a)
mastery of core contraction, (b) static holds and slow
movements in a stable environment, (c) static holds
in an unstable environment and dynamic movement
in a stable environment, (d) dynamic movements in
an unstable environment, and (e) resisted dynamic
movement in an unstable environment.

The exercises were carefully selected to incorporate
skill components necessary for effective tennis perfor-
mance; however, all of the exercises could be used to
improve core stabilization of any athletic population.
The exercises were specifically arranged in the training
program sequence to follow the guidelines proposed by Jeffreys. Thus, they incorporate center of gravity
control (i.e., multi-planar lunges), eccentric control (i.e.,
med ball twists on Swiss ball) and isometric control
(i.e., abdominal hollowing) to enhance dynamic balance. The exercises are progressed through three levels
of progressive difficulty (Table 1). The level-one exer-
cises are performed in a stationary position with static
contractions and are progressed to slow movements in
an unstable environment (Figures 1 and 2). Level-two
exercises involve static contractions in an unstable
environment, which are progressed to dynamic move-
ments in a more stable environment (Figure 3). Level
three exercises involve dynamic movements in an
unstable environment, followed by the addition of
resistance to the dynamic movements (Figures 4 and
5). The exercises involve the use of body weight, Swiss
Balls, tennis racquets, medicine balls, and therapeutic
resistance bands.

### Table 1. Jeffreys Progressive Core Stability Program

<table>
<thead>
<tr>
<th>Classification</th>
<th>Characteristic</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery of core contraction</td>
<td>Static isometric contraction</td>
<td>Side bridge</td>
</tr>
<tr>
<td>Static holds and slow movements in stable environment</td>
<td>Static isometric contraction with controlled simultaneous limb movement</td>
<td>Dead bug</td>
</tr>
<tr>
<td>Static holds in unstable environment and dynamic movement in a stable environment</td>
<td>Static isometric contraction on an unbalanced surface/body movement on a static surface</td>
<td>Abdominal isometric contraction on a Swiss ball</td>
</tr>
<tr>
<td>Dynamic movements in an unstable environment</td>
<td>Body movement on an unbalanced surface</td>
<td>Trunk twists on a Swiss ball</td>
</tr>
<tr>
<td>Resisted dynamic movement in unstable environment</td>
<td>Resisted body movement on an unbalanced surface</td>
<td>Trunk twists with Theraband on Swiss ball</td>
</tr>
<tr>
<td>Level</td>
<td>Exercises</td>
<td>Sets/reps</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Level 1: Week 1</td>
<td>Abdominal muscle contraction – supine</td>
<td>3x20</td>
</tr>
<tr>
<td>Day 1-3</td>
<td>Abdominal muscle contraction – quadruped</td>
<td>2x15</td>
</tr>
<tr>
<td>(Figure 1)</td>
<td>Abdominal muscle contraction – side bridge (R &amp; L)</td>
<td>1x6/each side (10 sec holds)</td>
</tr>
<tr>
<td>Level 1: Week 2</td>
<td>Dead bug – supine</td>
<td>3x20</td>
</tr>
<tr>
<td>Day 4-6</td>
<td>Bridging – quadruped</td>
<td>3x15</td>
</tr>
<tr>
<td>(Figure 2)</td>
<td>Seated medicine ball rotation</td>
<td>3x15</td>
</tr>
<tr>
<td>Level 2: Week 3</td>
<td>Abdominal muscle contractions</td>
<td>1x20</td>
</tr>
<tr>
<td>Day 1-3</td>
<td>Seated on Swiss ball</td>
<td>3x20</td>
</tr>
<tr>
<td>(Figure 3)</td>
<td>Squat with Swiss ball</td>
<td>3x15</td>
</tr>
<tr>
<td></td>
<td>Superman - supine</td>
<td>3x15</td>
</tr>
<tr>
<td>Level 2: Week 4</td>
<td>Abdominal muscle contraction</td>
<td>1x20</td>
</tr>
<tr>
<td>Day 4-6</td>
<td>Multidirectional lunge (R &amp; L)</td>
<td>3x15</td>
</tr>
<tr>
<td>(Figure 4)</td>
<td>Oblique pulley with side shuffles</td>
<td>3x15</td>
</tr>
<tr>
<td></td>
<td>Standing wall cross toss (R &amp; L)</td>
<td>3x20</td>
</tr>
<tr>
<td>Level 3: Week 5</td>
<td>Abdominal muscle contractions</td>
<td>1x20</td>
</tr>
<tr>
<td>Day 1-3</td>
<td>Diagonal curls on Swiss ball (R &amp; L)</td>
<td>3x10</td>
</tr>
<tr>
<td>(Figure 5)</td>
<td>Twists on Swiss ball while holding medicine ball (R &amp; L)</td>
<td>3x15</td>
</tr>
<tr>
<td></td>
<td>Standing with tennis racquet on unstable surface (R &amp; L)</td>
<td>4x10</td>
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</table>

**Figure 1**  Level 1: Week 1 (Abdominal muscle contraction)

**Figure 2**  Level 1: Week 2
Figure 3  Level 2: Week 3

Figure 4  Level 2: Week 4
Core Stabilization Training Program in a Clinical Study

This core stabilization training program was used in a five-week training study involving tennis players (3 times per week on alternating days). Dynamic postural control was assessed by the Star Excursion Balance Test, which was administered before and after the five-week training program. The Star Excursion Balance Test utilizes an eight-point star floor pattern to assess the length of 8 excursions in the anterior, posterior, medial, lateral, anteromedial, anterolateral, posterolateral, and posteromedial directions. The athletes maintained a unilateral stance on the center of the star pattern, while performing a maximal excursion with the nonstance limb. To normalize the data, excursion distance was expressed in terms of leg length. Our assessment compared the performance of an aged-matched control group with that of tennis athletes from a Division III institution. Although no difference was found between groups, there were significant differences between pre-training and post-training excursion distances in all directions ($p < .05$). We feel confident that the training program improves dynamic postural control in tennis players.

Summary

Tennis is a sport that involves multidirectional movement patterns that challenge the ability to maintain dynamic stability. Tennis players need a stable core to effectively perform upper and lower extremity movements. The core stabilization program presented in this report incorporates the skill components necessary for effective tennis performance. The exercises emphasize eccentric and isometric muscle actions that are believed to enhance dynamic postural control. We feel that the five-week training study program produced positive effects on dynamic postural control, and that continuation of the program for a longer period of time will provide further benefit.

REFERENCES


Kim Samson is a staff personal trainer/athletic trainer at Axis Performance Center in Mountain View, CA.

Michelle Sandrey is an associate professor and graduate athletic training program director at West Virginia University.

Allison Hetrick is an assistant athletic trainer working with gymnastics and tennis at West Virginia University.
Core training has become a staple of almost all conditioning programs. Whether it is for high-level athletes, the weekend warrior, or your average fitness enthusiast, “working the core” tends to get a lot of attention by fitness professionals, their clients, and the general public alike. Unfortunately, still to this day, there are many misconceptions on what the core truly is, how it functions, as well as how to properly design a progressive core training program. Far too often fitness professionals are asked by their clients or prospective clients, “How do I get rid of this?” as they grab the... Local stabilization muscles of the core. Provide support from vertebra to vertebra. Transverse abdominis. We designed a tennis-specific training program based on prior work in other sports in which neuromuscular retraining techniques were incorporated along with athletic performance enhancement drills in a program known as Sportsmetrics. None of the athletes played other sports or were involved in other training programs while participating in our program. Over the course of the study collection period, 15 athletes voluntarily participated in more than one training program. Our program incorporated many exercises for core stabilization and strengthening and all but 4 players improved in the posttrain abdominal endurance test. Context: Core training specifically for track and field athletes is vague, and it is not clear how it affects dynamic balance and core-endurance measures. Objective: To determine the effects of a 6-week core-stabilization-training program for high school track and field athletes on dynamic balance and core endurance. Design: Test-retest. Setting: High school in north central West Virginia. Participants: Thirteen healthy high school student athletes from 1 track and field team volunteered for the study. Interventions: Subjects completed pretesting 1 wk before data collection. They completed a
Conclusion: Core stabilization training program may improve the static and dynamic balance and can be used with other training programs. Kimberli SM, Sandrey MA. A core stabilization training program for tennis athletes. J Athl Ther Today 2005; 12: 41-6.

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