Introduction

To ensure that elite level tennis players perform at their highest level requires extensive practice, physical training and challenging competition. Maintaining this high level of performance and meeting the demands of training, however, can ultimately lead to overuse injuries. Regular physical testing, to identify areas of weakness and/or inflexibility, is an important part of optimizing performance while preventing injury.

The USA Tennis High Performance Profile (HPP) is a series of musculoskeletal tests put together to screen players and identify potential injuries before they occur. The purpose of the HPP is to highlight strength and/or flexibility deficits and identify areas where players should focus their physical training.

Instructions for Players, Parents and Coaches

The HPP was designed to be administered by a qualified healthcare provider (e.g., an orthopedist, physical therapist, certified athletic trainer or chiropractor). We recommend discussing the HPP with your healthcare provider to first describe the purpose of the HPP and also to ask if they would be able to perform the tests.

You should also take this brochure with you at the time of the testing as it describes how the tests should be performed. If you have difficulty locating a healthcare provider in your area, please contact the USTA Sport Science Department by any of the means listed below and we will try to help you find someone who can perform these tests.

Please sign the enclosed data sheet and return it to the USTA Sport Science Department after your healthcare provider has filled in the required information.

Instructions to the Healthcare Provider

The High Performance Profile was designed to identify strength imbalances and areas of weakness and/or inflexibility that could potentially lead to injury. These tests, described in the following pages, are fairly straightforward and should be easy to perform. However, should questions arise, please contact the USTA Sport Science Department.

These tests require very little equipment and it is likely you have everything you will need right in your office. Specifically the tests require:

- Two light (1-2 pound) hand weights
- Goniometer
- Blood pressure cuff
- Hand-grip dynamometer
- Tape measure

We ask that you return the HPP to the player and also forward a copy of the results to the USTA, after obtaining consent from the player and his/her parent, if necessary. To facilitate this, we have included a data sheet that can easily be faxed or mailed to the USTA Sport Science Department.

After the Test

Perhaps the most important part of the testing is not the tests themselves, but rather what is done with the results of these tests. The HPP provides important information that can be used in the development of tennis-specific training programs for any tennis player. After performing the HPP, the healthcare provider should be able to provide valuable feedback, including exercises and stretches that can be used to improve performance and prevent injury. A list of exercises that can be performed to address deficiencies can also be found on the USTA High Performance website, www.highperformance.usta.com. Re-testing should be performed every 3-4 months to assess improvement.

Questions? Contact the USTA Sport Science Department

Additional information on the High Performance Profile can be obtained by contacting the USTA Sport Science Department by phone at (305) 365-8760, by e-mail at sportscience@usta.com, or by accessing the USA Tennis High Performance website, www.highperformance.usta.com.
Scapular Stabilization Test (Scapular Dyskenesis Test)

Importance
The scapula, or shoulder blade, is the base for arm movement and an anchor for muscular attachments in the upper back and shoulder. The scapula must be lined up and move with the arm in a coordinated manner for the shoulder to function properly. This test checks for scapular motion and control of that motion.

Testing Method
In a standing position, the player holds a one-pound weight in each hand. The player begins the test with both arms at the sides (Figure A). The player should elevate the straight arms 180° in the scapular plane with the thumbs pointed upward (Figure B). After reaching the “top position” the player slowly lowers the arms back to the sides. The examiner observes the movement of the shoulder blades, and notes any winging or overuse of neck and upper trapezius muscles during both the ascent and descent phases of elevation. Asymmetry also is noted. This is especially important as the arms are lowered back to the sides.

When abnormal scapular motion is noted the prominence of the scapular borders are noted and can be classified according to the Kibler Scapular Dyskinesis System, outlined below:

Type I: Inferior Angle: The inferior medial scapular border may be prominent dorsally at rest. Additionally, during arm motion, the inferior angle of the scapula tilts dorsally and away from the thorax.

Type II: Medial Border: The entire medial border of the scapula may be prominent at rest, and with arm motion. Additionally, the medial border of the scapula may tilt dorsally off the thorax.

Type III: Superior Border: The superior border of the scapula may be elevated at rest and with arm motion. A shrug type motion initiates the movement without significant dorsal protrusion of the scapula.

Type IV: Symmetric Scapulohumeral: At rest, both shoulder blades are relatively symmetrical. The dominant shoulder may be significantly lower. During arm motion, the shoulder blades should rotate symmetrically upward, such that the inferior angles translate laterally away from the midline and the scapular medial border remains flush against the thoracic wall. The reverse should occur during arm lowering.

The picture on the left (A) shows the proper starting position and the picture on the right (B) illustrates the “top position” of the scapular stabilization test. The player should raise and lower the arms in the scapular plane and the examiner should watch for scapular winging or other compensatory actions that are made to assist the movement.
Test Results and Comments

Is a Scapular Pathology Noted?

Left Shoulder: Y N

Right Shoulder: Y N

*Note: Kibler Type I, II or III are considered abnormal and indicate scapular pathology. When players exhibit scapular pathology, it is recommended that they receive some type of intervention. Type IV, symmetrical scapulohumeral rhythm, is considered normal.

Comments/Observations:

____________________________________________________________________________________________

____________________________________________________________________________________________

____________________________________________________________________________________________

____________________________________________________________________________________________
External Rotation Strength (Manual Muscle Test)

**Importance**
The rotator cuff is responsible for stabilizing the shoulder during virtually all arm movements. Strength and muscular endurance in the external rotator muscles (back part of the rotator cuff) are essential for the prevention of shoulder injury. This assessment manually tests the strength of the rotator cuff.

**Testing Methods**
In either a seated or standing position, the examiner places the player's shoulder in 90 degrees of abduction and 90 degrees of external rotation in the coronal plane (90/90 position – Figure A). The elbow is placed in 90 degrees of elbow flexion so the fingers point toward the ceiling. While stabilizing the player's elbow with one hand, the examiner exerts a force, pushing the arm into internal rotation, while instructing the player to hold the initial 90/90 position. The examiner grades the performance of the test as follows:

5  (Normal)—Ability to maintain 90/90 position without pain against maximal resistance applied by the examiner. The arm does not “break” from the 90/90 position with testing.

4  (Good)—Ability to maintain 90/90 position without pain against moderate resistance applied by the examiner. The hand and forearm move slightly into internal rotation with heavier amounts of resistance applied by the examiner.

3  (Fair)—Inability to withstand any resistance applied by the examiner.

2  (Poor)—Inability to even place arm in the 90/90 position.

**Test Results and Comments**

Left Shoulder: _____ / 5  Right Shoulder: _____ / 5

Comments/Observations:

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
Grip Strength Test

**Importance**
Strength of the wrist and forearm muscles is important for tennis players to stabilize the elbow and wrist joints during play. Grip strength also is used as a gross estimate of upper extremity strength. Research has shown that the dominant arm is often 10-20% stronger in grip strength from holding the racquet.

**Testing Method**
Using a hand grip dynamometer (Figure A), the player squeezes the dynamometer with the arm held down at the side with the elbow near full extension (Figure B). Record the result in kilograms and perform the test three times bilaterally.

![Image A](image1.png)

![Image B](image2.png)

**Test Results and Comments**

Left Arm Grip Strength: ____________________ kg

Right Arm Grip Strength: ____________________ kg

Comments/Observations:

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
**Shoulder Internal/External Rotation (Active ROM Test)**

**Importance**
Loss of range of motion (ROM) in the shoulder creates abnormal movement of the shoulder ball and socket joint, which may predispose a player to injury. This inflexibility also decreases effective long axis rotation, which can, in turn, negatively affect performance.

**Testing Method**
Shoulder ROM is measured with the player lying supine on a treatment table. Abduct the testing arm to 90° with elbow flexed to 90°. The player's fingers should point upward toward the ceiling in the starting (0°) position. The examiner should exert a posteriorly directed force on the front the shoulder throughout the test, to ensure that the scapula is stabilized. The player slowly moves the arm into external (Figure A) and internal rotation (Figure B). This test measures a player's active range of motion and the examiner should not apply overpressure to the arm. The examiner measures and records the angle bilaterally using a universal goniometer. Total rotation is calculated by summing the internal and external rotation measures.

**Test Results and Comments**

<table>
<thead>
<tr>
<th></th>
<th>External Rotation</th>
<th>Internal Rotation</th>
<th>Total Range of Motion</th>
<th>Average Total Range of Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant Arm</td>
<td></td>
<td></td>
<td></td>
<td>150±10°</td>
</tr>
<tr>
<td>Non-Dominant Arm</td>
<td></td>
<td></td>
<td></td>
<td>160±10°</td>
</tr>
</tbody>
</table>

Comments/Observations:
________________________________________
________________________________________
________________________________________
________________________________________
**Importance**

The one-leg stability test highlights a player's ability to control the body over a planted leg. Having adequate strength and control in the lower limbs is important in order to decrease the loads experienced by the knee and leg (injury risk) and to allow for explosive starts and stops (performance enhancement).

**Testing Method**

The player begins in an upright standing position with both arms at the sides. The examiner instructs the player to bend the non-weight bearing knee to 90° (Figure A) and descend into a squat position, bending the weight bearing knee approximately 30-45° (Figures B and C). This position should be held briefly before returning to the starting position (Figure A). Repeat on each side, as many as 10-times per side, and note any fatigue-related effects. Instructions to the player should be to maintain good postural alignment and a neutral spine throughout the movement. The examiner should report any abnormal movements, some of which are described on the following page.

**Proper Form**

![Starting Position](image1)

![Descent Position (front)](image2)

![Descent Position (side)](image3)
Common Abnormalities

Several movement abnormalities that are frequently seen when performing the one-leg stability test include: lateral bowing or corkscrewing of the body and lower limb (Figure D), an inability to control the pelvis on the weight bearing side (Trendelenburg pattern), resulting in the dropping of the opposite hip (Figure E), and increased trunk flexion during the movement (Figure F). The examiner also should note if the knee of the weight-bearing limb translates past the toes during the exercise.

Test Results and Comments

Left Stance Limb—Comments:

Right Stance Limb—Comments:
**Hip External Rotation** (Patrick’s Test)

**Importance**
A lack of external rotation in the hip decreases a player’s ability to generate maximal force in the lower extremity and transfer that force to provide power during tennis strokes.

**Testing Method**
The test begins with the player lying supine on a treatment table. With a pen, the examiner marks the lateral border of the patella on each lower extremity. The examiner then passively flexes, abducts and externally rotates the hip of one lower extremity, placing the lateral malleolus of that extremity just proximal to the patella of the contralateral limb that remains extended on the exam table. The player is then asked to relax his/her hip and allow the knee to drop toward the floor naturally; the examiner should not provide any overpressure. When the end range of motion is reached, the examiner should measure the distance between the lateral border of the patella and the treatment table with a tape measure. The sequence is repeated for both limbs.

**Test Results and Comments**
Left Hip distance between the lateral border of patella to treatment table (cm): ____________________

Right Hip distance between from lateral border of patella to treatment table (cm): ____________________

Comments/Observations:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
**Hip Flexor Flexibility (Thomas Test)**

**Importance**
Tightness of the hip flexors, including the rectus femoris, can cause lower back dysfunction and decrease a player’s lower body power and movement capability.

**Testing Method**
The player lies supine on a treatment table, such that the edge of the table lines up with the middle of the player’s femurs. Both legs should hang over the edge of the table. The player brings both knees up and as close to the chest as possible. The player continues to hold one leg toward the chest and lowers the other leg passively, allowing it to drop over the edge of the table. Achieving neutral hip extension (thigh touching table) signifies the hip flexors are of normal length. An inability to achieve neutral hip extension indicates a positive Thomas test and a goniometer can be used to measure the resultant angle of hip flexion, as measured from the horizontal. Additional testing to assess muscle length of the rectus femoris can be performed using the same procedure and ensuring that the leg being lowered maintains 90° of knee flexion, without creating a flexion response at the hip. The contralateral leg should remain against the player’s chest throughout these tests.

![Example of Good Flexibility](image1)

![Example of Poor Flexibility](image2)

**Test Results and Comments**

<table>
<thead>
<tr>
<th></th>
<th>Thomas Test (+/-)</th>
<th>Hip Angle if Positive</th>
<th>Rectus Femoris Test (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Leg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Leg</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments/Observations:

-----------------------
-----------------------
-----------------------
-----------------------
-----------------------
Hamstring Flexibility (Straight Leg Raise)

**Importance**
Flexible hamstrings allow for optimal hip motion and for explosive power to be developed in the lower body. Hamstring flexibility also reduces the risk of lower back and knee injury.

**Testing Method**
The player lies supine on the examination table with a neutral spine position. The leg not being tested is kept on the examination table with the knee completely straight. The examiner raises the testing leg while monitoring the player’s anterior superior iliac spine (ASIS) of the pelvis. The leg is raised passively until motion is felt or observed at the ASIS. The hip flexion angle is measured with a goniometer. This test is performed bilaterally. Normal hip range of motion in this test has been reported as 70-80°.

![Example of Good Flexibility](image1)

![Example of Poor Flexibility](image2)

**Test Results and Comments**

Left leg raise right leg: ______________ degrees

Right leg raise left leg: ______________ degrees

Comments/Observations:

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
Quadriceps Flexibility (Prone Quadriceps Flexibility Test)

**Importance**
Flexibility of the quadriceps is important to decrease knee injury and improve lower body range of motion.

**Testing Method**
The player lies prone on a treatment table with a neutral spine position. The limb not being measured is placed in an extended position. The examiner bends the tested knee toward the buttock for normal results. A goniometer can be used to formally measure in degrees the amount of knee flexion achieved during testing. The test is performed bilaterally.

**Example of Good Flexibility**

**Example of Poor Flexibility**

**Test Results and Comments**

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>Angle, if measured:</th>
<th>___________ degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Heel to Buttock:</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Heel to Buttock:</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments/Observations:

_________________________________________________________________________

_________________________________________________________________________
Core Stabilization Strength (Blood Pressure Cuff Test)

**Importance**
The core musculature surrounds the body’s center of gravity and controls the motion of the pelvis. All movements involve the use of the body’s core. Insufficient strength in the core musculature, or the inability to control the force in these muscles, can lead to injury and/or less than optimal performance.

**Testing Method**
The player lies in a supine position on a rigid surface (e.g., the floor or a treatment table) with a neutral spine position. A blood pressure cuff is inflated and put under the small of the back (Figure A). The player raises both legs into a position of 90° hip flexion and 90° knee flexion while contracting the transverse abdominus (TA) and other core muscles. Ensure the TA is engaged via palpation. The examiner should inflate the blood pressure cuff to read a pressure of 40 mmHg (Figures A and B). The player then actively lowers one leg until the foot is approximately 15 cm (~6 inches) off the ground, holding this end position for 10 seconds while maintaining a constant pressure of 40 mmHg in the blood pressure cuff (Figure C). The player then raises the leg and repeats the movement with the opposite limb. This is done 10 times for each leg to allow the examiner to note any effects of fatigue. The goal of the player is to maintain a constant pressure in the blood pressure cuff for the entire exercise.

**Test Results and Comments**

Left-Leg Lowering: Player has the ability to maintain 40 mmHg during testing: YES NO

Right-Leg Lowering: Player has the ability to maintain 40 mmHg during testing: YES NO

Comments/Observations:
References

Scapular Stabilization (Scapular Dyskinesia Test)

External Rotation Strength (Manual Muscle Test)

Grip Strength Test

Shoulder Internal/External Rotation (AROM Test)


Hip External Rotation (Patrick's Test)

Hip Flexor Flexibility (Thomas Test)

Hamstring Flexibility (Straight-Leg Raise)

*The High Performance Profile is a product of the USTA Sport Science Committee copyright 2004.*

Photography: (Front cover, left to right): Clive Brunskill/Getty Images; USTA High Performance; Mike Hewitt/Getty Images; Back Cover: Jed Jacobsohn/Getty Images; Lance Jeffrey.