



THE TENNIS PLAYER IN MOTION

CHAPTER

1

Elite tennis players make it look so easy and effortless. By comparison, your movement skills, strokes, and fitness may leave something to be desired. Good coaches can help you improve technique and fitness, but keep in mind that there are many individual differences, even at the professional level. You can see that Roger Federer and Rafael Nadal don't play exactly the same way. They do have in common a desire to perfect their skills and a drive to continue to improve both technique and physical preparation. Proper technique, however, can be attained only if you can produce all necessary movements throughout the range of motion required for optimal positioning and stroke execution.

The sport of tennis requires strength, flexibility, power, endurance, and speed. Each of these components requires a well-trained muscular system. In addition, each court surface provides a different challenge. For example, clay courts require players to play longer rallies—sometimes as much as 20 percent longer—than do hard courts, and grass courts are even faster than most hard courts. Therefore, players who usually play on clay should train muscular endurance, while players who usually play on faster surfaces such as hard or grass courts may want to train more for muscular power or at least a combination of endurance and power.

Tennis is a lifelong sport, and the goal for many of us is to continue to enhance our performance while staying injury free, whether playing recreationally, in tournaments, at the college level, or even at the professional level. The best way to do this is to train effectively and use proper technique, seeking to produce effective and efficient tennis strokes. Consider the demands of tennis, but keep in mind your unique playing style and body structure.

Physical Demands of Tennis

Proper movement skills are critical for successful tennis. A successful tennis player must be able to get to the ball early and set up properly. Typically, this requires quite a few adjustment steps as you recognize the path, spin, and pace of the incoming ball. In fact, tennis often has been characterized as a game of emergencies. It involves constant movement, short sprints, and frequent directional changes. On average, 3 to 5 directional changes are required per point, and it is not uncommon for players to perform more than 500 directional changes during a single match or practice. Matches can last several hours, which requires aerobic fitness, but the short sprints, explosive movements, and directional changes are clearly anaerobic. Therefore, both the cardiorespiratory and muscular systems should be trained using movement patterns representative of those seen during tennis play.

A big focus of the United States Tennis Association (USTA) Player Development training program is good movement and positioning. It is clear that if you can't get to the ball and set up properly, you won't hit the ball in the most balanced way to produce a forceful stroke. The legs are the first link in transferring forces from the lower to the upper body. This is part of the kinetic link, or kinetic chain, system. Newton's third law states that for every action there is an equal and opposite reaction. When you hit a tennis ball, your feet push against the ground, and the ground pushes back. This allows you to transfer force from one body part to the next, through the legs, hips, trunk, and arm all the way to the racket. The key is to do this in the most efficient and effective manner by timing the segments correctly, not leaving out any segments, and preparing your body to be strong and flexible enough to handle the stresses imposed. Proper technique and preparation of the muscular system should go hand in hand. The lower body, midsection (the core or torso), and upper body are important in tennis, but each segment has different needs and training requirements.

Training the legs is vital for efficient movement on the court. Research shows that the muscles in both legs are stressed equally in tennis, so training programs should reflect this. Since the vast majority of tennis movements are side to side, it is important to focus 60 to 80 percent of training on these movement patterns. In other words, working on lateral movements incorporating the abductors, the muscles that move the leg away from the center of the body, and the adductors, the muscles that bring the leg toward the center of the body, is at least as important as training the other muscle groups of the legs.

Think of the midsection of the body as a cylinder when it comes to training. Exercises should be designed to move the front, back, and side of the torso through multiple planes of motion. Tennis strokes require rotational movements as well as flexion and extension, frequently all in one stroke.

The dominant side of the upper body is much more involved in each stroke than the nondominant side. Therefore, in addition to training the dominant side for performance purposes, you need to train the nondominant side for balance and injury prevention. Since the game tends to be dominated by serves and forehands that involve the muscles of the front of the shoulders and the chest, be sure to train the muscles in the rear of the shoulders and the back. During forehands and serves, these muscles experience eccentric, or lengthening, contractions and shorten during the backhand stroke through concentric contractions.

When designing a training program for tennis players, it is important to balance upper and lower body, left and right sides, and front and back. *Tennis Anatomy* takes you through each of the body parts and provides you with appropriate exercises for optimal performance.

Playing Styles and Court Surfaces

Muscular balance is key for all players regardless of surface or playing style. However, your playing style and the surface you play on most often will influence your training goals and affect your exercise choices. For example, if you

play a lot of long points on clay courts, you will want to train for endurance, especially in the lower body, instead of muscular strength and power, which would be more appropriate for a player who plays shorter points on hard courts. The same principle holds for the upper body, but to a lesser extent. You will still likely hit the ball just as hard when playing on a slower court; however, muscular endurance becomes more important since the points are longer. Regardless of playing style or surface, the upper body should be trained for both muscular power and endurance.

Playing Styles

Do you know what your playing style is? Do you like to come to the net and put the ball away with a volley or overhead? Or are you the type of player who likes to outlast your opponent by never missing a ball? Or do you like to hit the ball hard from the baseline, trying to dictate points and go for winners? All three styles can be very effective. Which style you use depends on your skills, personality, and possibly the court surface you play on most frequently. Most coaches categorize players into four different playing styles:

1. Serve and volleyer
2. Aggressive baseliner
3. Counterpuncher
4. All-court player

At the top professional level, the aggressive baseliner is the most prevalent, followed by the all-court player. The traditional serve and volleyer and the stereotypical counterpuncher are no longer preferred playing styles on either the men's or women's tours. However, tennis players at other levels can be seen playing each of these different styles.

The serve and volleyer (figure 1.1, page 4) relies on the serve to help dictate the point. After the serve, she explodes forward to the net. Typically, a serve and volleyer moves forward 20 to 40 percent more than a counterpuncher or an aggressive baseliner and about 20 percent more than an all-court player. Because of this forward movement, a serve and volleyer often finds herself at the net, trying to finish the point. Good volley technique is imperative and requires excellent leg strength, particularly in the quadriceps, gluteus maximus, and gastrocnemius. Strong leg muscles are key, especially for hitting low volleys that require significant knee flexion. Functional flexibility is very important to the serve and volleyer because she is required to get very low to the ground dozens of times throughout the match. Similarly, flexibility of the wrist is helpful, especially in reaching for volleys that stress the end range of the joint. This flexibility needs to be trained regularly.

The aggressive baseliner (figure 1.2, page 4) is more comfortable hitting groundstrokes but is also looking to put pressure on his opponent by hitting hard, aggressive strokes. This player's goal is to move less than the counterpuncher, and he prefers to move inside the court and take balls earlier to reduce the opponent's time between strokes. Muscular strength and

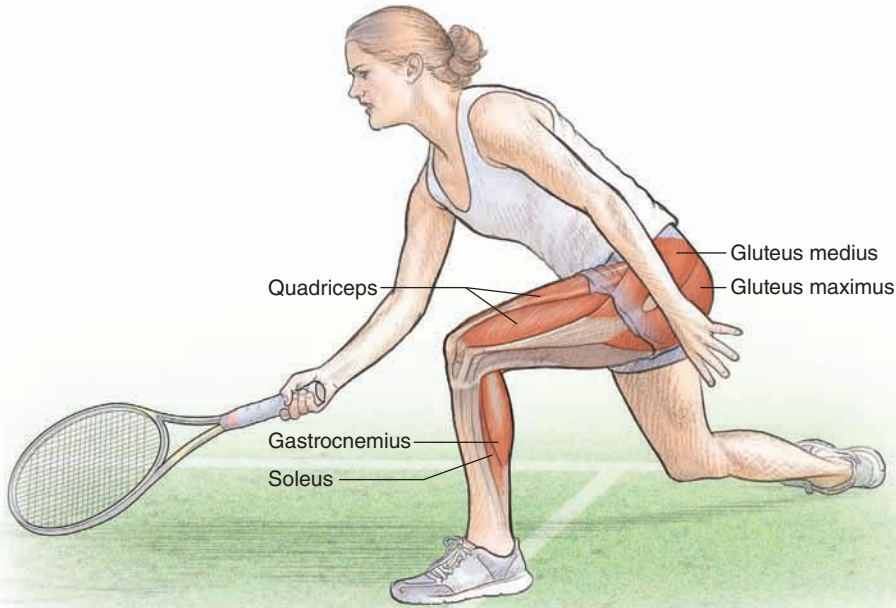


Figure 1.1 Serve and volleyer on a grass court hitting a low volley.

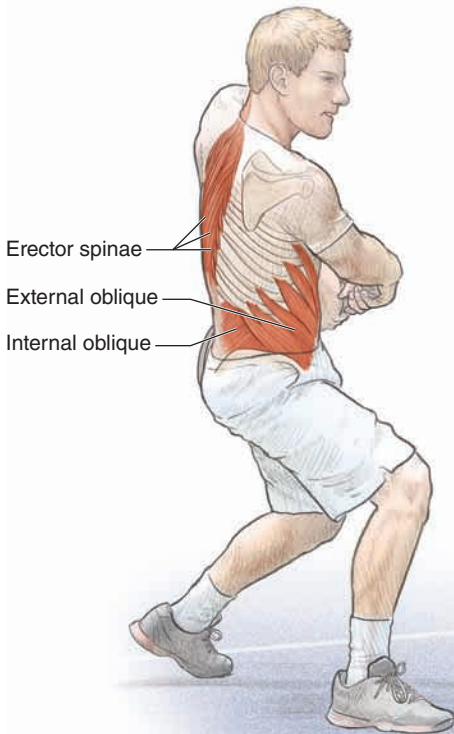


Figure 1.2 Aggressive baseliner on a hard court hitting a two-handed backhand.

endurance are required, but overall power is the major physical component that helps the aggressive baseliner dictate points. Having a major weapon such as a big forehand or strong two-handed backhand is very beneficial. Powerful strokes require strength as well as speed. Training exercises should take this into account. Exercises for the lower body and midsection should be very similar to those mentioned for players with other styles, but a greater emphasis on upper body power is helpful. The muscles of the chest and front of the shoulders are important for producing force, but don't neglect the muscles of the back of the shoulders and upper back. They help protect the shoulder complex and prevent injury.

The goal of the counterpuncher (figure 1.3) is to chase down every ball and make sure the opponent has to hit many balls each rally to win any points. This game style is based on great side-to-side movement and stroke consistency.

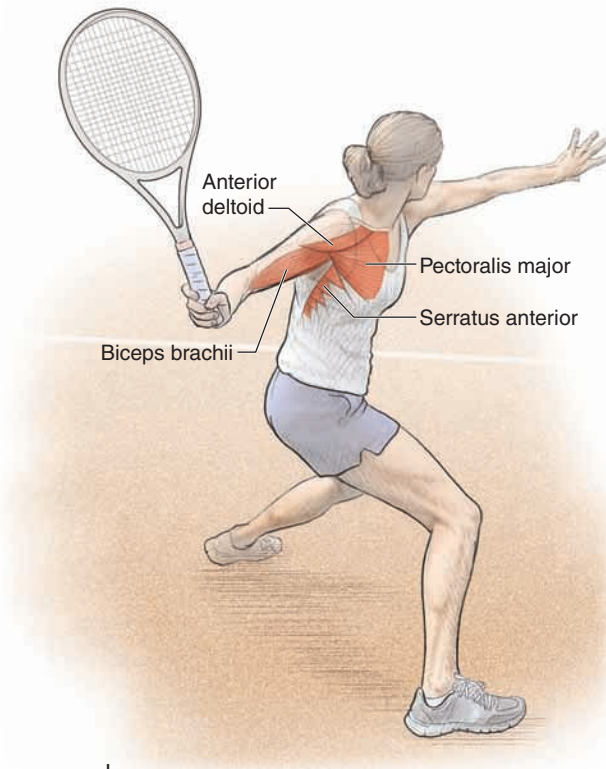


Figure 1.3 Counterpuncher on a clay court sliding to hit a wide forehand.

The counterpuncher moves laterally 60 to 80 percent of the time. Often she will stretch out to hit open-stance forehands or backhands. Therefore, it is critical to train the abductors and adductors as well as the muscle groups mentioned for the serve and volleyer in a well-rounded training program. This includes training flexibility as well as strength. The counterpuncher must depend on speed, quickness, and the ability to change direction since she may not often put the ball away for a winner. This type of game style is most effective on slower courts. Muscular endurance of the upper and lower body is critical. The obliques must be trained to assist in the rotational movements of all groundstrokes since the counterpuncher hits so many strokes, most with an open stance. Also, when playing great defense, the counterpuncher may hit many strokes when on one leg, out of position, or off balance. Therefore, it is imperative to train for these situations on the court by performing single-leg activities and training in unstable or irregular environments.

The all-court player (figure 1.4, page 6) looks to be aggressive when hitting groundstrokes but is also happy to follow aggressive shots to the net to finish points. All shots, from serves to groundstrokes to volleys, require equal attention in training. In addition, significant time should be spent on the transition game, training for shots that help the all-court player get to the net. The all-court player should regularly practice approach shots, such as a big forehand or slice backhand hit from half court, and follow each shot to the net. These shots require excellent movement and positioning, most often with a more closed stance than regular groundstrokes. Exercises for both the upper

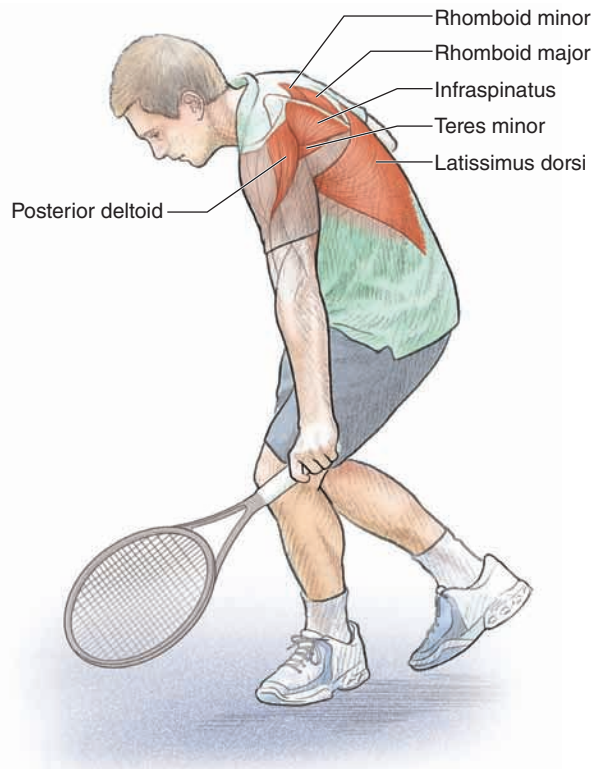


Figure 1.4 All-court player on a hard court hitting a one-handed slice backhand approach shot.

and lower body are beneficial, especially exercises that help develop weight transfer and movement into the court such as the spider drill (page 174) and the split step with stimulus drill (page 177) in chapter 9. It is important to train all muscle groups. The main focus should be on balancing between left and right, front and back, and upper and lower body.

Court Surfaces

Court surface does dictate playing style to a certain extent. In general, a serve and volleyer can be more successful on a faster grass court than on a clay court. A counterpuncher typically is more successful on a slower clay court than on any other surface.

Since balls bounce lower on grass courts and fast hard courts, players must be able to bend their knees well. Training should focus on exercises that take the body through the same range of motion expected during a match (e.g., full-range lunges and squats), with powerful recoveries. Players who play on clay often have to slide into their shots while hitting a wide forehand or backhand. Since playing on clay requires not only front and back leg strength but also muscular strength of the inside and outside of the legs, it is vital to train the abductors and adductors. Muscular endurance should be the focus. Researchers have compared the ball speed on hard courts and clay courts. After the ball lands on a clay court, the ball speed is typically reduced by 15 percent compared with the same ball on a hard court. This is a major reason

why points are longer on clay courts and more strokes are hit per rally. Longer points on clay courts will slightly increase heart rate compared with shorter points on hard courts. Therefore, training to prepare for playing on a clay court will require a greater emphasis on aerobic conditioning versus training to play on a hard court. Service games are more physically demanding than return games, so players with weaker serves need to be prepared to play longer points and use a more physically demanding style.

Tennis Strokes

Tennis Anatomy features many exercises to improve your tennis game. Some are multijoint exercises, such as the lunge, which uses the hips, knees, and ankles. Others are single-joint exercises, such as the calf raise, which uses just the ankle joint. All exercises will be useful to prevent injuries and enhance performance. It is just as important to get fit to play tennis as it is to use tennis to get fit. Therefore, the exercises in the following chapters will help you prepare to take your game to the next level.

To identify how each exercise benefits your game, we provide icons to indicate the specific strokes—groundstrokes (forehand and backhand), serves and overhead shots, and volleys (forehand and backhand)—that will benefit from the conditioning exercise. In this section, we explain the major strokes and how actions, muscles, and muscle contractions are interrelated to produce effective and powerful strokes.

Forehand and Backhand Groundstrokes

Over the past 30 years, the greatest changes in tennis likely have occurred because of changes in racket technology. Rackets are made out of a variety of materials and are wider and stiffer, featuring a larger sweet spot. This has had a tremendous impact on the game, nowhere more than in the groundstrokes. The larger sweet spot is more forgiving on off-center hits, and the racket materials allow for more forceful swings. Because of these changes, forehand and backhand swings have changed as well. The long, flowing swings and follow-throughs in the direction of the target have given way to more violent, rotational swings that end up across the body in a variety of positions depending on the type of shot. These swing patterns allow players to hit the ball from a more open stance, particularly when hitting forehands but also when hitting two-handed backhands. This rotational component can put a significant amount of stress on the midsection. Therefore, exercises preparing the body for these stresses are vitally important.

Many of the muscle actions in the lower body are similar for all of the tennis strokes. There is an interplay between eccentric (lengthening) and concentric (shortening) actions that allows the body to store and release energy based on the phase of each stroke. In addition, each stroke requires trunk rotation, more so for groundstrokes, serves, and overheads than for volleys. The forehand, serve, and overhead strokes differ from one- and two-handed backhand strokes in that the upper body muscles are activated in the opposite way. The muscles in the upper back and back of the shoulder act concentrically (shorten) in the

loading phase and eccentrically (lengthen) in the follow-through. The muscles of the chest and front of the shoulder first contract eccentrically during the backswing and then concentrically during the forward swing. The backhand swing follows an opposite pattern.

Forehand Groundstroke

The forehand groundstroke may be hit from an open stance, a square stance, or a closed stance. Each body position requires different lower and upper body mechanics, although all three stances use a combination of angular and linear momentum to power the stroke. Linear momentum is a product of both mass and velocity and can be generated in both a vertical and horizontal direction. Angular momentum refers to the rotational component of the stroke and takes into account both the moment of inertia about an axis (resistance to rotation about that axis) and the angular velocity about that axis. Both linear and angular momentum are fundamental for the successful generation of power in the forehand. The amount of linear momentum created affects the amount of rotational force that is generated about each of the body segments.

The open-stance forehand (figure 1.5) results in the greatest total body rotation and requires greater strength and flexibility throughout the core and lower body than the square-stance or closed-stance forehand. The square- and closed-stance forehands require less rotation at the core, and ball contact is made more in front of the player and closer to the net. It is important to understand that each of the stances is situation specific. In other words, where

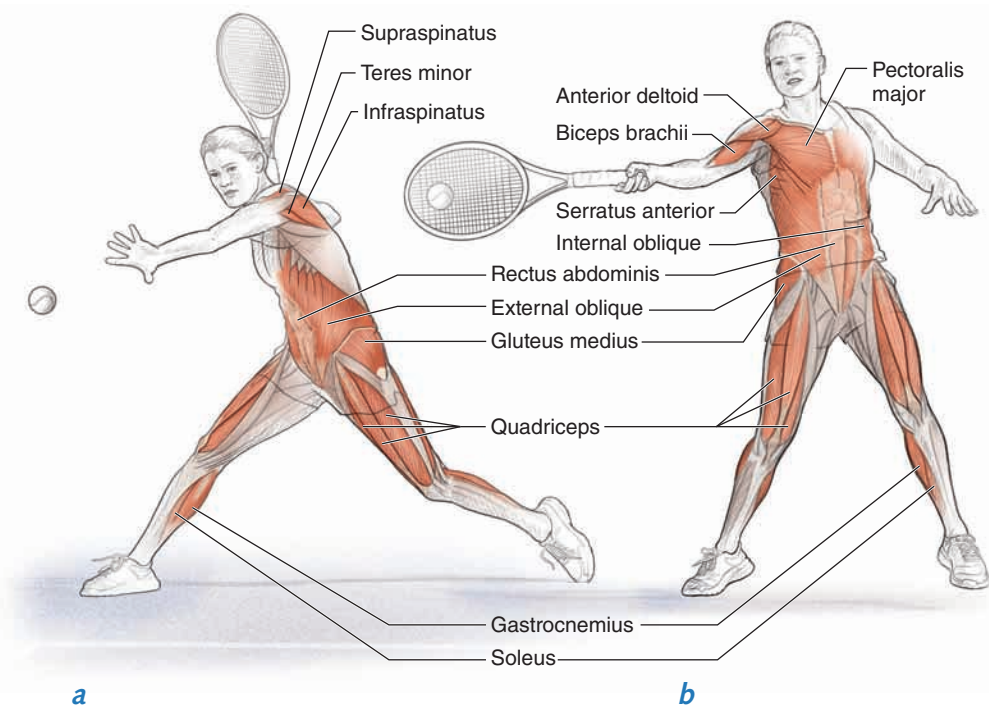


Figure 1.5 Open-stance forehand: (a) backswing; (b) forward swing.

you are on the court, the type of ball coming at you (both speed and spin), and the shot you are trying to hit often affect your stance.

The open-stance forehand is the most commonly used forehand in today's game. This shot requires vigorous hip and upper trunk rotation to provide effective energy transfer from the lower body through the core and into the racket and ball at impact. Trunk rotation, horizontal shoulder abduction, and internal rotation are the main motions that create racket speed in the forehand. After ball impact, eccentric strength helps decelerate the racket. This is particularly important as it relates to injury prevention.

During the backswing of the forehand groundstroke (figure 1.5a), the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators contract eccentrically to load the lower legs and begin the hip rotation. The concentric contractions of the trunk rotation phase involve the ipsilateral internal oblique and contralateral external oblique, while the eccentric contractions pull in the contralateral internal oblique, ipsilateral external oblique, abdominals, and erector spinae. The concentric contractions of the shoulder and upper arm rotation in the transverse plane are performed by the middle and posterior deltoid, latissimus dorsi, infraspinatus, and teres minor and are followed by contractions of the wrist extensors. The eccentric contractions of the shoulder and upper arm rotation in the transverse plane are performed by the anterior deltoid, pectoralis major, and subscapularis.

During the forward swing (figure 1.5b), the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators contract both concentrically and eccentrically to drive the lower body and hip rotation. Concentric and eccentric contractions of the obliques, back extensors, and erector spinae cause the trunk to rotate. The latissimus dorsi, anterior deltoid, subscapularis, biceps, and pectoralis major all contract concentrically during the acceleration phase to bring the racket to the ball for contact.

During the follow-through, the upper arm movement decelerates through the eccentric contractions of the infraspinatus, teres minor, posterior deltoid, rhomboids, serratus anterior, trapezius, triceps, and wrist extensors.

One-Handed Backhand Groundstroke

The one-handed backhand (figure 1.6, page 10) involves the summation of forces similar to the forehand, but there are important differences as well. The strength and muscular endurance of the wrist extensors are important for successful repeated performance of the backhand. Research has shown that torque at the wrist can create a rapid stretch of the wrist extensors, especially in players who have a history of tennis elbow (lateral epicondylitis).

For a one-handed backhand, the dominant shoulder is in front of the body. Typically, the stroke uses less trunk rotation; however, it requires a more coordinated action of the different body segments, including shoulder and forearm rotation, than the two-handed backhand. The front leg is more involved during a one-handed backhand than during a two-handed backhand. Similar racket speeds can be achieved with one- and two-handed backhands. Strength and flexibility, particularly of the muscles of the upper

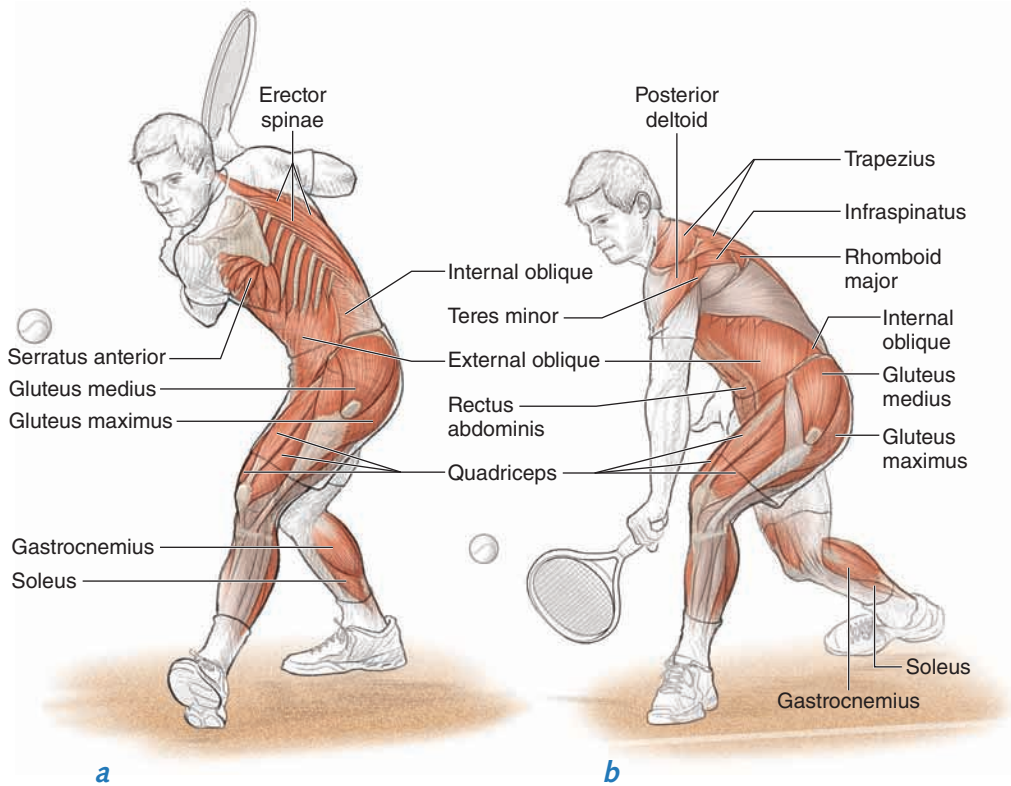


Figure 1.6 One-handed backhand: (a) backswing; (b) forward swing.

back and back of the shoulders, are key. Perform training exercises bilaterally to achieve muscular balance.

During the backswing of the one-handed backhand (figure 1.6a), the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators contract eccentrically to load the legs and begin the hip rotation. The concentric contractions of the ipsilateral internal oblique and the contralateral external oblique are balanced by the eccentric contractions of the contralateral internal oblique, ipsilateral external oblique, abdominals, and erector spinae to rotate the trunk. The anterior deltoid, pectoralis major, subscapularis, and wrist extensors contract concentrically to rotate the shoulder and upper arm through the transverse plane as the posterior deltoid, infraspinatus, teres minor, trapezius, rhomboids, and serratus anterior contract eccentrically.

During the forward swing (figure 1.6b), the lower body and hip rotation is driven by the concentric and eccentric contractions of the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators. Concentric and eccentric contractions of the obliques, back extensors, and erector spinae cause the trunk to rotate into the shot. The acceleration phase of the upper arm is performed through concentric contractions of the infraspinatus, teres minor, posterior deltoid, and trapezius.

During the follow-through, the subscapularis, pectoralis major, biceps, and wrist flexors contract eccentrically to decelerate the upper arm.

Two-Handed Backhand Groundstroke

Many players benefit from the two-handed backhand (figure 1.7), especially in the early learning stages. Both arms are used, increasing the power of the stroke, and fewer body segments are involved, which helps learning players coordinate the movement. These benefits help players hit balls in the strike zone and balls that bounce higher that must be hit above shoulder level. Although the two-handed backhand uses many of the same muscle groups as the one-handed backhand, the two-handed backhand requires greater trunk rotation versus the one-handed backhand. Therefore, the muscles of the torso and midsection should be well trained, especially the internal and external obliques. This is especially important in open-stance backhands, which are becoming more prevalent at all levels of the game. In addition, the legs should be trained to provide a stable base of support, to properly transfer the forces from the ground to the racket, and to provide endurance for long matches. One area unique to the two-handed backhand is the use of the nondominant arm and wrist. The flexors and extensors of the nondominant forearm and wrist and the muscles involved in ulnar and radial deviation must be trained appropriately.

During the backswing (figure 1.7a), the eccentric contractions of the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators load the legs and begin the hip rotation. Concentric contractions of the ipsilateral internal oblique and contralateral external oblique are aided by eccentric contractions

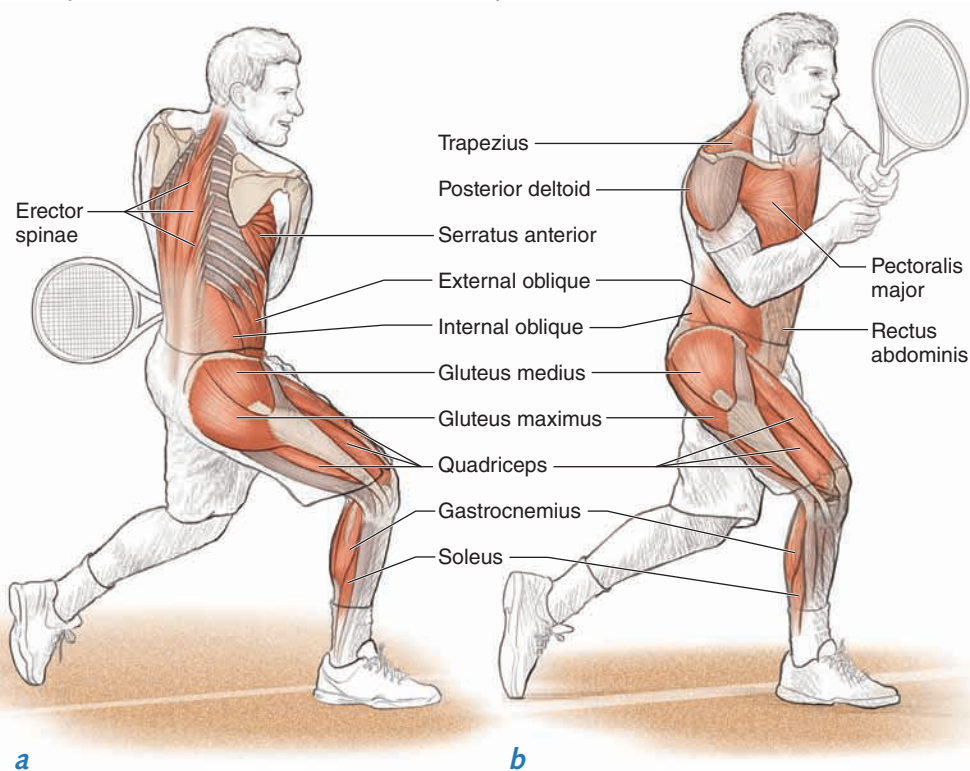


Figure 1.7 Two-handed backhand: (a) backswing; (b) forward swing.

of the contralateral internal oblique, ipsilateral external oblique, abdominals, and erector spinae. The shoulder and upper arm on the dominant side rotate through the transverse plane through concentric contractions of the anterior deltoid, pectoralis major, subscapularis, and wrist extensors and eccentric contractions of the posterior deltoid, infraspinatus, teres minor, trapezius, rhomboids, and serratus anterior. On the nondominant side, concentric contractions of the middle and posterior deltoid, latissimus dorsi, infraspinatus, teres minor, and wrist extensors create the rotation of the shoulder and upper arm, assisted by eccentric contractions of the anterior deltoid, pectoralis major, and subscapularis.

During the forward swing (figure 1.7*b*), concentric and eccentric contractions of the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators drive the lower body and hip rotation. Concentric and eccentric contractions of the obliques, back extensors, and erector spinae rotate the trunk. The upper arm on the dominant side moves to the ball through concentric contractions of the infraspinatus, teres minor, posterior deltoid, and trapezius. On the nondominant side, concentric contractions of the anterior deltoid, subscapularis, biceps, serratus anterior, and pectoralis major bring the arm to the ball.

During the follow-through, the dominant arm decelerates through eccentric contractions of the subscapularis, pectoralis major, and wrist flexors. The nondominant arm decelerates through eccentric contractions of the infraspinatus, teres minor, posterior deltoid, rhomboids, serratus anterior, trapezius, triceps, and wrist extensors.

Serves and Overheads

The serve is one of the most important shots in tennis. Each player starts half the points with a serve, for which he has time to prepare. The serve has become a true weapon in the game because it can dictate much of what happens in the ensuing point. Since the swing pattern of the overhead is quite similar to that of the serve, we are including it in this section as well.

From a strategy and tactics perspective, the main keys to a successful serve are pace, spin, and placement. The best servers combine all three components. Of course, physical preparation to develop strength, power, flexibility, and coordination determines the quality of these three components.

A good serve has become more important in professional tennis. Statistics from the 2009 U.S. Open Tennis Championships show that for the men's event, 5 of the top 10 ranked players also had the highest service speed. The women's game has followed a similar trend. You also can make the serve a true weapon by preparing your body for the rigors of serving at a high level for an entire match.

In the modern game, we see two types of serves: the foot-up serve (figure 1.8) and the foot-back serve (figure 1.9, page 14). Either serve is acceptable. Typically, the player chooses which serve to use based on personal preference and style. In the foot-up serve, the rear foot typically starts in the same position as for the foot-back serve. However, during the toss and backswing, the back foot slides up to join the front foot. This allows for more forward weight

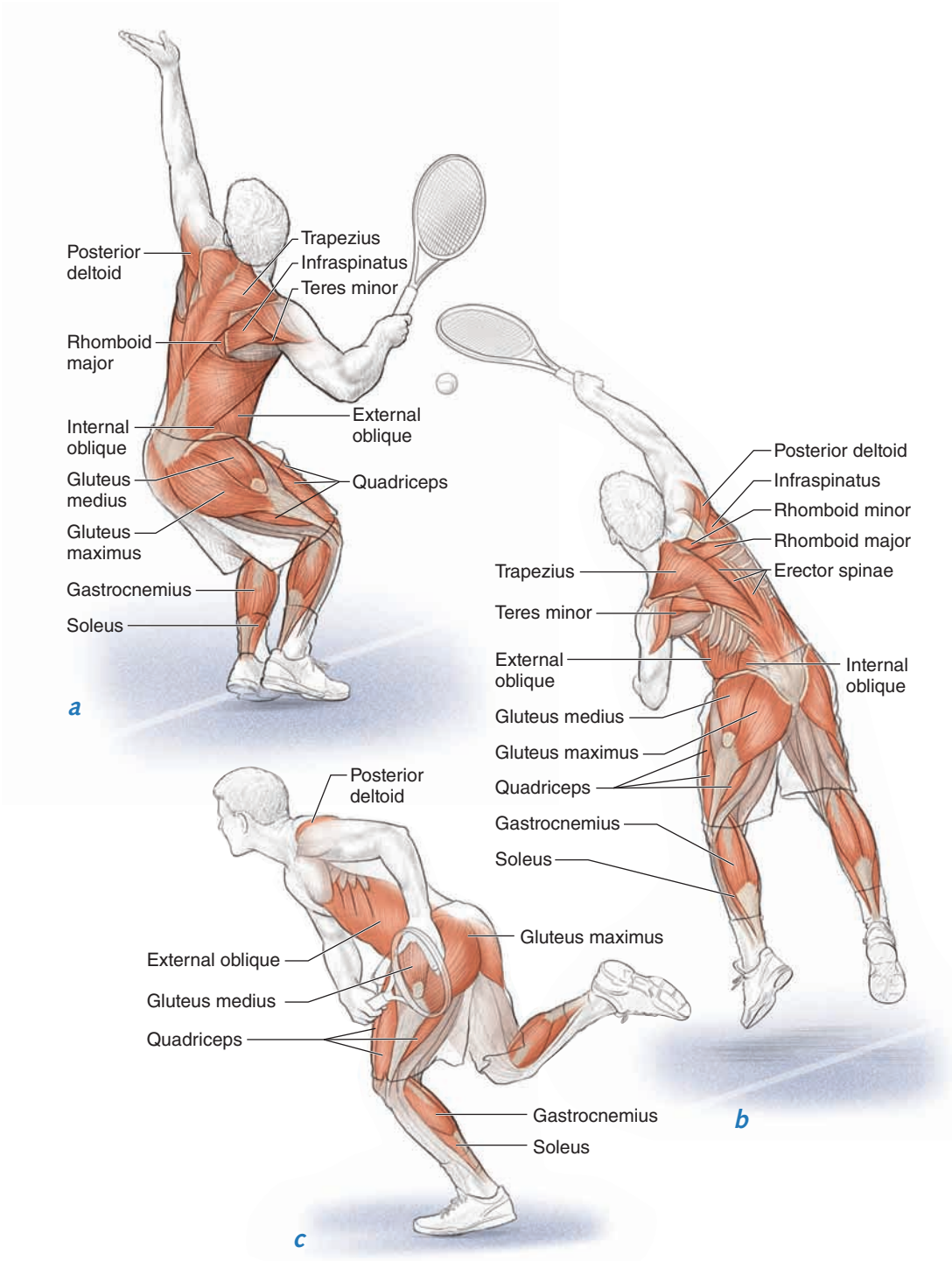


Figure 1.8 Foot-up serve: (a) loading; (b) acceleration; (c) follow-through.

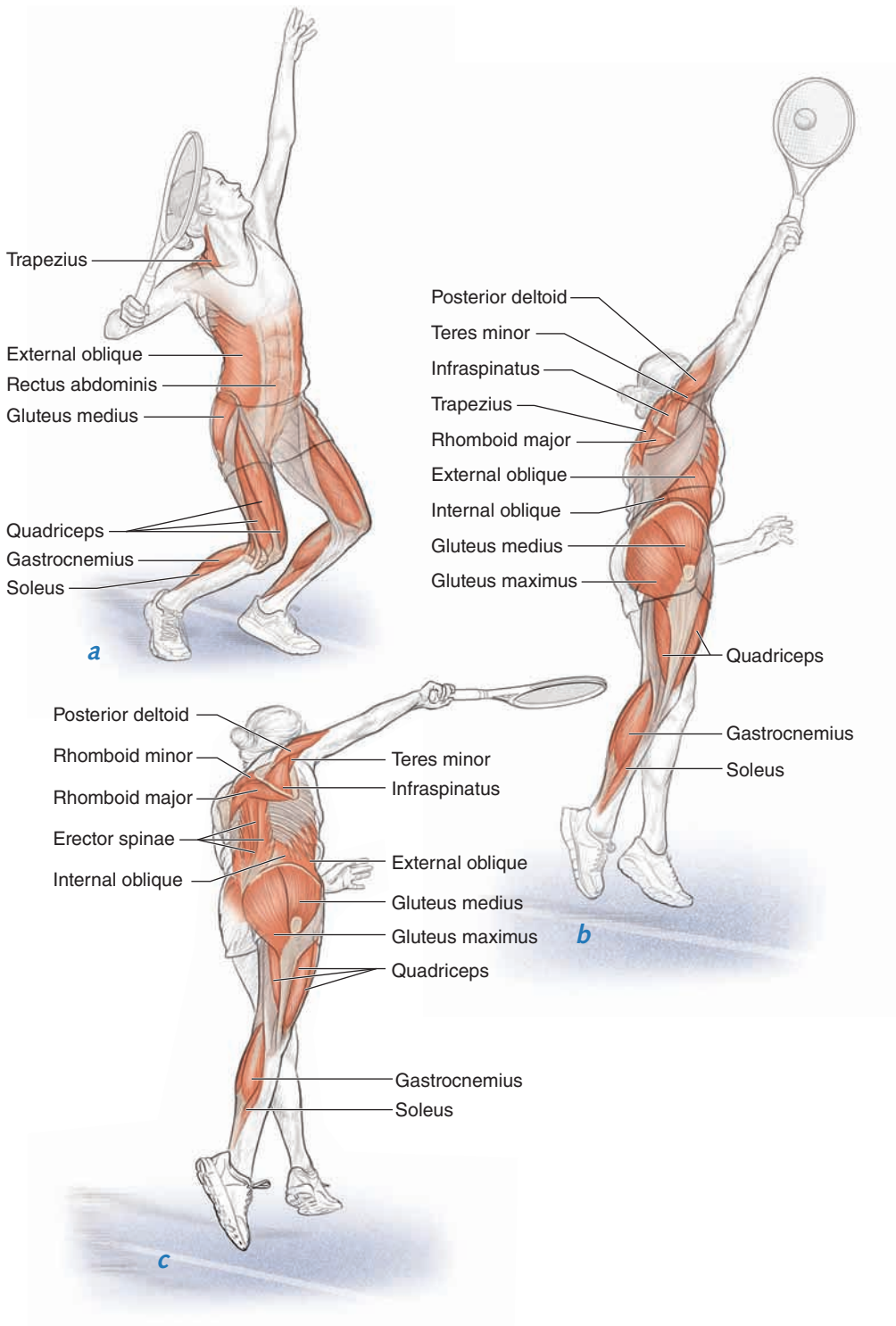


Figure 1.9 Foot-back serve: (a) loading; (b) acceleration; (c) follow-through.

transfer as well as the ability to open up the hips easier during the forward swing. The foot-back position allows for a slightly more balanced position and possibly more upward (vertical) force production.

The execution of the serve or overhead has three major phases: loading, acceleration, and follow-through. During the loading (or preparation) phase, you are storing energy. The acceleration phase is when you release the energy through the end of ball contact. The last phase, the follow-through (or deceleration) phase, requires great eccentric strength to help control the deceleration of the upper and lower body.

A successful serve or overhead is the result of the summation of forces from the ground up through the entire kinetic chain and to the ball at impact. Knee flexion (eccentric contractions of the quadriceps) occurs to instigate effective ground reaction forces, the first major force-producing aspect of the service motion. This knee flexion often is defined as lower body loading. The gastrocnemius, soleus, quadriceps, gluteals, and hip rotators contract eccentrically to load the legs and begin hip rotation. During this stage of the serve or overhead, a counterrotation of the trunk, core, and upper body occurs to store potential energy that will ultimately be used in the service motion to transfer energy through impact. During this loading phase, a lateral flexion of the shoulders also increases potential energy storage. This energy will be released just before and during ball impact. The obliques, abdominals, and trunk extensors contract concentrically and eccentrically to rotate the trunk.

During the arm-cocking stage of the serve or overhead at the point of maximal external shoulder rotation, the dominant shoulder might be rotated as much as 170 degrees. The back extensors, obliques, and abdominals contract concentrically and eccentrically to extend and rotate the trunk. Concentric contractions of the infraspinatus, teres minor, supraspinatus, biceps, serratus anterior, and wrist extensors and eccentric contractions of the subscapularis and pectoralis major move the arm.

From this position there is an explosive vertical component that results in concentric contractions of the major muscles of the dominant arm and shoulder. The muscles in the front of the chest and trunk (the pectorals, abdominals, quadriceps, and biceps) are the primary accelerators of the upper arm, while the muscles in the back of the body (the rotator cuff muscles, trapezius, rhomboids, and back extensors) are the major decelerators during the follow-through. The leg drive is executed through concentric contractions of the gastrocnemius, soleus, quadriceps, and gluteals and eccentric contractions of the hamstrings. Concentric contractions of the abdominals and obliques and eccentric contractions of the back extensors flex and rotate the trunk. The elevation and forward movement of the upper arm are achieved through concentric contractions of the subscapularis, pectoralis major, anterior deltoid, and triceps. The elbow extends through the concentric contraction of the triceps and the eccentric contraction of the biceps. Concentric contractions of the latissimus dorsi, subscapularis, pectoralis major, and forearm pronators internally rotate the shoulder and pronate the forearm. Wrist flexion is created through the concentric contractions of the wrist flexors.

As a player lands, eccentric contractions of the gastrocnemius, soleus, quadriceps, and gluteals decelerate the body. Eccentric and concentric contractions of the back extensors, obliques, and abdominals flex and rotate the trunk. Eccentric contractions of the infraspinatus, teres minor, serratus anterior, trapezius, rhomboids, wrist extensors, and forearm supinators decelerate the upper arm.

The overhead motion and technique are similar to the service motion. This is particularly true when players keep the feet on the ground when executing the overhead (figure 1.10). Typically, this overhead is used to return a short lob or when the ball bounces first. The muscular involvement is the same as for the serve; however, the swing pattern, especially the backswing, might shorten just slightly because of time constraints. The overhead with a scissor kick (figure 1.11) has a similar swing pattern for the upper body, but the lower body action includes a takeoff from the rear leg and a landing on the opposite leg after the ball is struck. This scissor-kick action produces force and helps with reach and balance during and after the shot. Significant concentric involvement from the gluteals, quadriceps, gastrocnemius, and soleus is required, particularly in the takeoff leg. These same muscles act as a shock absorber (eccentric contraction) in the landing leg.

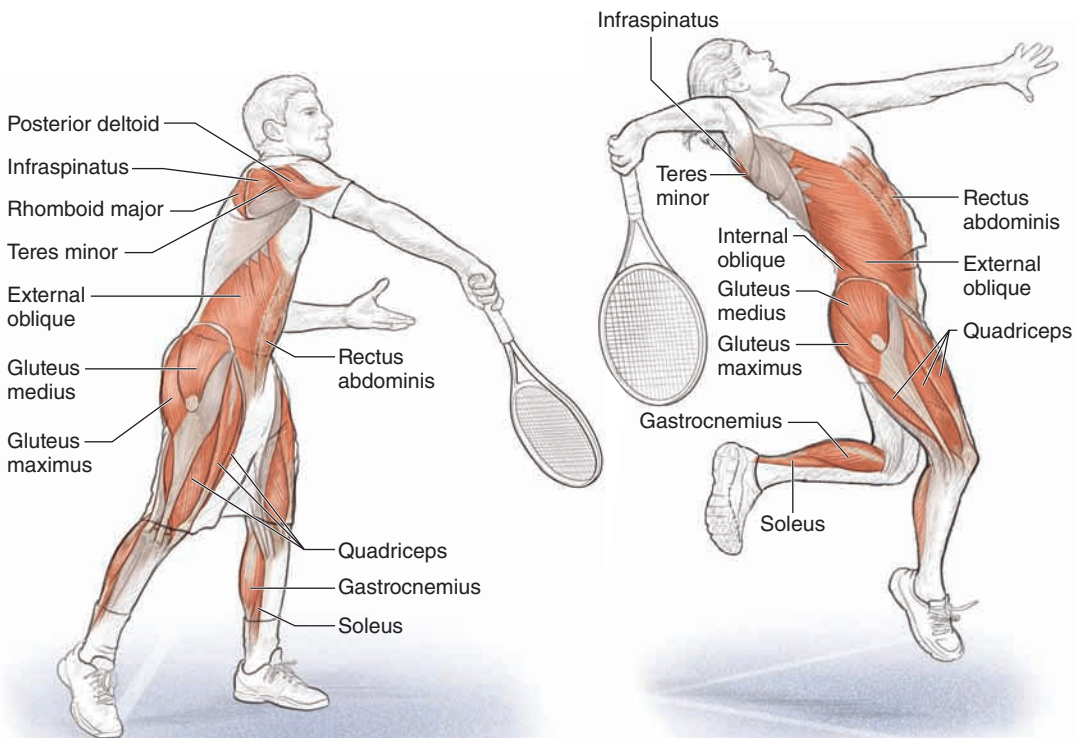


Figure 1.10 Follow-through after hitting an overhead with the feet on the ground.

Figure 1.11 Backswing before hitting a scissor-kick overhead.

Volleys

Although elite players don't come to the net as much as they used to since passing shots have improved significantly with new equipment, volleys are still an important part of the game, especially if you predominantly play doubles. The net game is still critical for doubles play at every level. Many points in doubles are won by a well-angled volley or put-away overhead. In addition, as players adjust to strong passing shots, they will learn new skills and methods related to attacking the net. All-court players in particular are continually looking for ways to end the point by moving forward. Many athletes who do not play at the professional level also look for a variety of ways to put away the ball.

Being fit enough to endure a long match while pressuring your opponent could be the difference between winning and losing. Coaches know that good volleys are hit with the feet as well as the hands. You have to be in proper position to volley well. Therefore, training the legs is probably the most important activity you can participate in to become a good volleyer. Lunges in all directions should receive particular attention because these movements mimic the on-court demands for volleying.

Since volleys require excellent movement skills, training the legs is key. Volleys require similar lower body movements as groundstrokes; however, the muscular actions may be more exaggerated. Greater flexion and extension at the hips, knees, and ankles in particular are likely. In addition, many of these movement patterns will be repeated at a faster speed the closer you are to your opponent. Muscles of the lower body need to be trained eccentrically as well as concentrically. Volleys are shorter strokes with an abbreviated backswing and follow-through compared with groundstrokes, although the same upper body muscles are used. Therefore, eccentric strength for the follow-through is key for immediate success and protection of the muscles surrounding the shoulder joint.

If players have time, they often hit volleys with closed stances (see figures 1.12 and 1.13). Since the swing is shorter, weight transfer becomes more important. Stepping forward facilitates the weight transfer.

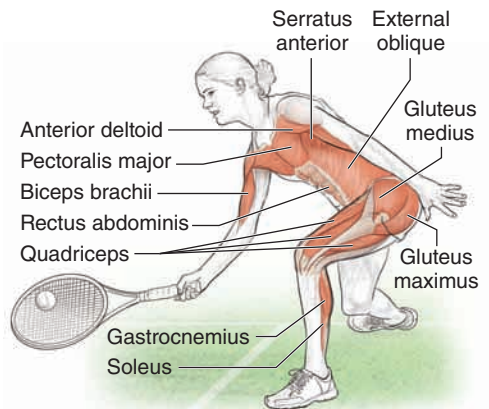


Figure 1.12 Closed-stance forehand volley at contact.

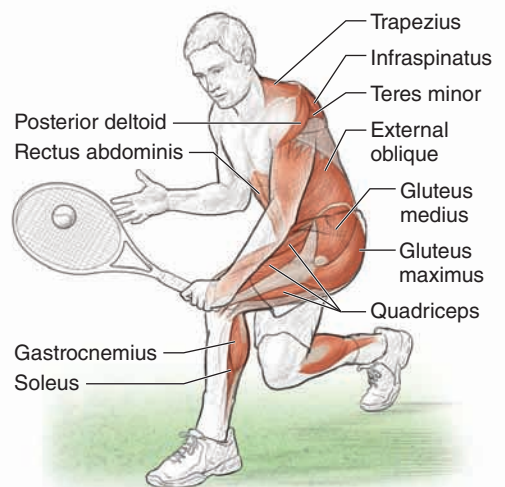


Figure 1.13 Closed-stance backhand volley at contact.

During the backswing of both the forehand and backhand volleys, the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators contract eccentrically to load the lower legs and begin the hip rotation. The concentric contractions of the trunk rotation phase involve the ipsilateral internal oblique and contralateral external oblique, while the eccentric contractions pull in the contralateral internal oblique, ipsilateral external oblique, abdominals, and erector spinae. For the forehand volley, the concentric contractions of the shoulder and upper arm rotation in the transverse plane are performed by the middle and posterior deltoid, latissimus dorsi, infraspinatus, and teres minor and are followed by contractions of the wrist extensors. The eccentric contractions of the shoulder and upper arm rotation in the transverse plane are performed by the anterior deltoid, pectoralis major, and subscapularis. In the backhand volley, these concentric and eccentric actions are exactly opposite.

During the forward swing of both the forehand and backhand volleys, the gastrocnemius, soleus, quadriceps, gluteals, and hip rotators contract both concentrically and eccentrically to drive the lower body and hip rotation. Concentric and eccentric contractions of the obliques, back extensors, and erector spinae cause the trunk to rotate. For the forehand volley, the latissimus dorsi, anterior deltoid, subscapularis, biceps, and pectoralis major all contract concentrically during the acceleration phase to bring the racket to the ball for contact. For the backhand volley, the acceleration phase of the upper arm is performed through concentric contractions of the infraspinatus, teres minor, posterior deltoid, and trapezius.

During the follow-through phase of the forehand volley, the upper arm decelerates through the eccentric contractions of the infraspinatus, teres minor, posterior deltoid, rhomboids, serratus anterior, trapezius, triceps, and wrist extensors. During the backhand volley, the upper arm decelerates through the eccentric contractions of the subscapularis, pectoralis major, anterior deltoid, and biceps.

Training Considerations

Tennis Anatomy provides a number of exercises specific to tennis performance, targeting the muscles identified in this chapter. *Tennis Anatomy* also guides you beyond the exercises in this book to help you choose appropriate additional exercises to improve performance. A certified strength and conditioning specialist will be able to help you set up a training program specific to your needs and goals. This section covers some common training principles to help you get started on your way to becoming a well-conditioned player.

Adaptation

The body makes specific adaptations to training loads based on the load, intensity, type, volume, and frequency of training. Loads must be cyclical and progressive in order to produce continued improvement over time. Periodized programs are designed around cyclical progressive loading

throughout the training year. A good periodized program can help you peak for important tournaments such as club or state championships or even the U.S. Open.

People will respond differently to the same training program. Age, gender, height, weight, training age, tennis goals, and motivation all influence how players respond to a specific training program. Some athletes respond well to training that is more frequent and higher in intensity; others may fail to respond to this kind of program. Monitor your individual response to the training program, and make sure to include recovery periods to permit higher intensity during key training sessions and competition.

Adaptations to most forms of training are easily reversible. If you do not continue to train at a high enough level, you will not maintain the improvements you have made, and your performance will regress. Detraining is the loss of the physiological benefits of training. In general, aerobic detraining is more rapid because it is based on decreases in aerobic enzyme concentrations. Muscle strength is more resistant to rapid detraining, but it will decline within a few weeks of reduced or limited training. Flexibility can increase and decrease rather rapidly as well.

Load and Intensity

To achieve training adaptations such as power, speed, strength, endurance, and flexibility, you must load the specific variable greater than you currently do. However, be careful to add an appropriate load. Too much load too soon can result in injury or overtraining, which can lead to long-term effects such as burnout.

In resistance training, loading is sometimes expressed as a percentage of the greatest load a person can lift during a specific movement, a one-repetition maximum, or 1RM. For example, this could be how much weight you could squat for one repetition. Training loads can be calculated as a percentage of this value. Depending on the goal of the training session, the load may be applied during one repetition of the movement or over a number of repetitions. If a 1RM lift is contraindicated for you or not desired, you can estimate your 1RM based on the number of repetitions you complete with a lighter resistance. It is nearly as accurate to base your 1RM on a 3RM or 5RM. Intensity is often measured and tracked via the percentage of resistance based on your 1RM. Use loads (intensities) that represent 60 to 100 percent of your 1RM. During a few periods throughout the year, loads may approach 100 percent intensity, but this occurs only for short periods of time as part of a structured, periodized training program.

Different intensities result in different adaptations. Athletes who spend the majority of their time training at between 60 and 80 percent of 1RM with larger overall training volumes exhibit greater hypertrophy gains (i.e., increase in lean muscle mass). To improve absolute strength, intensities need to be above 80 percent of 1RM, with more rest periods and lower overall total volume. To improve muscular endurance, train at an intensity below 60 percent of 1RM.

Volume

The volume of training typically is noted as the number of sets and number of repetitions performed in each set. The volume of the training stimulus is similar to the duration of an aerobic training program. Total workload is strongly related to many of the effects of a resistance training program. Although beginners may show improvement using a single set of a specific number of repetitions, continued improvement will require a total workload.

To see the greatest improvements, perform two or three sets of most exercises. The number of repetitions performed per set and the level of resistance used depend on the goals of that particular phase of training. A good rule of thumb is to perform two to four sets of 6 repetitions or less for strength, 8 to 15 repetitions for hypertrophy, and 15 to 30 repetitions for muscular endurance. Typically, tennis players should use no more than 20 repetitions per set and no less than 6 repetitions per set for proper strength gains and endurance improvement.

Frequency

Frequency is a component that needs to be adjusted for the individual tennis player. The beginner can improve with just two training sessions per week. Advanced athletes usually need more training sessions to adapt to the training load as desired. Train similar muscle groups two or three times per week. Include recovery time of at least 24 hours between training sessions that work the same major muscle groups.

Rest

Rest is often one of the most overlooked areas of a training program, yet it can provide the greatest improvement in performance and reduce the likelihood of injury. It takes approximately three minutes for your immediate energy stores to replenish after a short training bout (i.e., 10 to 60 seconds of activity). You need to understand this when creating a training program based on energy system development. For the nervous system, recovery is just as important and is usually harder to measure and monitor. Fatigue is obvious when you run for 90 seconds as fast as you can. This is metabolic (i.e., energy system) fatigue. If you performed a few depth jumps from an 18-inch (46 cm) box, you would not feel the same fatigue, but you would have fatigued different mechanisms, predominantly neural mechanisms. Recovery is required in both situations, but you might not allow enough recovery time for the second example because you may not feel tired.

Rest between exercises depends on the order of the exercise prescription. If the next exercise uses a different muscle group, the length of rest can be shorter. If the same muscle is trained in the next set, the length of rest between exercises should be similar to the time between exercise sets. If the training goal is to increase muscle hypertrophy, rest 30 to 90 seconds between sets. If absolute strength is the goal, increase rest time between sets to two or three minutes or even longer. If muscular endurance is the goal, keep rest periods brief (less than 30 seconds).

Variability and Progression

Variability includes variation in load, speed of movement, rest periods, and exercise selection. Without such variability, an athlete may experience training plateaus and perhaps undertraining or overtraining.

Variation in load should occur in a periodized manner based on the goals and objectives of your long-term development. For example, to increase maximal strength, your program should have a hypertrophy phase followed by a strength phase. To increase power, your program should progress from a hypertrophy phase to a strength phase to a power phase. For a more in-depth discussion of periodization, check out *Periodization: Theory and Methodology of Training* by Tudor Bompá and G. Gregory Haff (Human Kinetics, 2009).

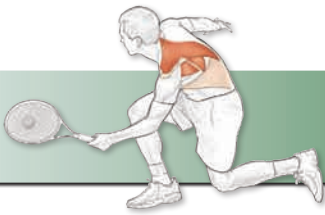
Daily Program Organization

Aside from the overall periodization effect of a training program, there are particular methods of organizing a program at the daily workout level. Daily program design relies on your training age, goals, motivation, playing style, lifestyle, other responsibilities, and other factors; the type of training goals; and the time available for training. Several methods of daily program design are possible.

A full-body routine is often used with beginners, but it can be a good routine for advanced athletes or those with limited time for training. Divide the body into lower body, core, and upper body. Within these three broad areas, the body is further broken down. Exercises for the upper body include a press motion, press motion above the head, pull motion, and pull motion from above the head. Core exercises focus on flexion, extension, and rotation motion. Lower body exercises include squats and lunges as well as focus on ankle plantar flexion and dorsiflexion. Repeat the full-body program no more than four times a week, with at least one day's rest between sessions. In general, it takes three training days per week to make significant gains and two days per week to maintain strength.

A second option is the upper–lower two-on, one-off split routine. In this organization, the body is divided into two groups—upper and lower body. This program design is more appropriate for those who have some training experience. The upper body is trained on the first training day and the lower body on the second training day. Core training may be structured in parts or grouped into a separate training session. Consider, though, that the core is active in nearly every strength and conditioning exercise, and the core is trained in nearly all movements on and off the court. Follow each training day with one day off, and then begin the cycle again. This ensures adequate rest without the loss of potential training effects.

Tennis-specific training can be accomplished in many different ways. A systematic approach that involves a periodized plan and appropriate tennis-specific movements will provide the greatest results, improving on-court performance and reducing the risk of injury. Enjoy the exercises in *Tennis Anatomy* as they help you enhance your performance on the court and stay injury free.



For a tennis player, the shoulder may be the most important joint in the body. The shoulder is not only a major area of focus for performance enhancement but also one of the most commonly injured areas in tennis players. The shoulder joint, also called the glenohumeral joint, is a multiaxial ball-and-socket joint. This allows it to be the most mobile joint in the body, providing the largest range of motion. Having a large range of motion around the shoulder is a clear advantage for a tennis player because the sport requires movements in multiple directions, including stretching for wide groundstrokes, lunging for low volleys, and reaching up to hit deep overheads. This great range of motion in multiple planes, although beneficial, also creates a joint that is relatively unstable. As a result, shoulder injuries, typically from overuse, are common in tennis players. The exercises in this chapter both develop the shoulder muscles involved in tennis strokes and enhance the movements of the shoulder for improved performance.

Shoulder Anatomy

Three bones—the humerus, scapula, and clavicle—are primarily involved in the movements of the shoulder. The humerus, the long bone of the upper arm, articulates with the scapula, or shoulder blade, at the shoulder joint and with the radius and ulna, the bones in the forearm, at the elbow. The clavicle, or collarbone, is connected to the core of the body via the sternum. The clavicle forms part of the pectoral girdle and articulates with the scapula. As the shoulder joint moves, the muscles around the shoulder move the scapula to help increase the range of motion of the shoulder. Without scapular movement, the shoulder joint alone can move only to approximately 120 degrees of flexion or abduction. The movement of the scapula allows the shoulder joint to add approximately another 60 degrees of motion in each of these directions.

A number of muscles are involved in shoulder movement. The subscapularis, supraspinatus, infraspinatus, and teres minor muscles and their related tendons and ligaments make up the rotator cuff (figure 2.1, page 24), which is one of the most commonly injured sites of the shoulder, particularly as it relates to overuse injuries. (Shoulder injuries and other common tennis injuries are discussed in more detail in chapter 10, along with exercises for the prevention and rehabilitation of these injuries.) The muscles of the rotator cuff are relatively small muscles whose tendons cross the front, top, and rear of the head of the humerus. The rotator cuff plays a vital role in maintaining the humeral head in the correct position, supporting the more powerful muscle—the deltoid (figure 2.2, page 24)—of the shoulder region.

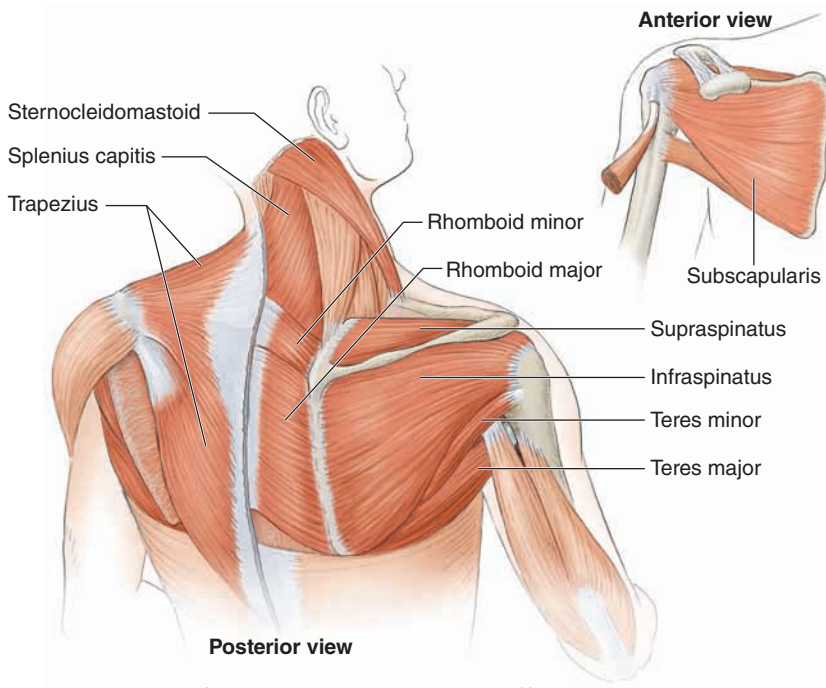


Figure 2.1 Muscles of the scapula and rotator cuff.

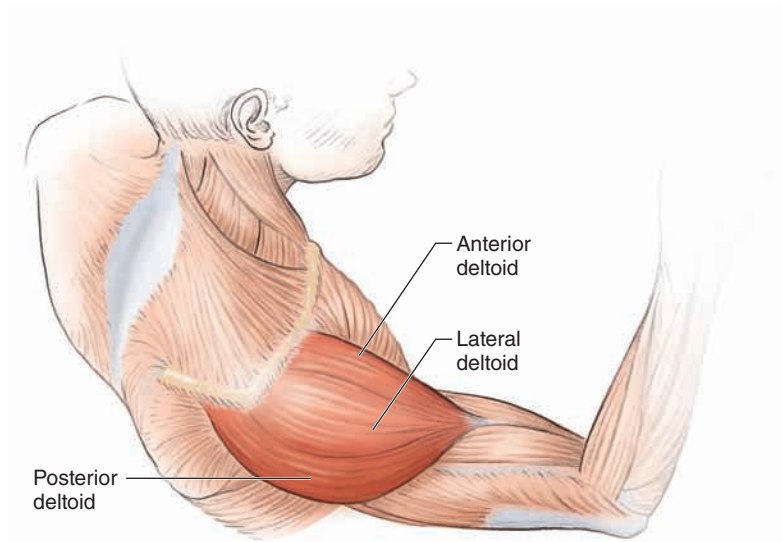


Figure 2.2 Deltoid muscle.

Technically, the shoulder complex consists of four joints—the sternoclavicular, acromioclavicular, glenohumeral, and scapulothoracic joints—that control the position of the humerus, scapula, and clavicle. The sternoclavicular joint connects the shoulder complex to the axial skeleton and allows for elevation and depression, protraction and retraction, and long-axis rotation of the clavicle. The acromioclavicular joint connects the clavicle to the acromion process of the

scapula and contributes to total arm movement. The two principle movements are elevation and depression during abduction of the humerus and a gliding movement as the shoulder joint flexes and extends. The articular surfaces of the glenohumeral joint are the head of the humerus and the glenoid fossa of the scapula. The way both are curved allows for a great amount of motion in all directions yet also provides minimal stability. The scapulothoracic joint not only serves as a protective mechanism for someone falling with an outstretched arm but also assists with glenohumeral stability and enhances arm–trunk motion.

The deltoid, coracobrachialis, teres major, and rotator cuff group are the intrinsic muscles of the glenohumeral joint. These muscles originate on the scapula and clavicle and insert on the humerus. The latissimus dorsi and pectoralis major are the extrinsic muscles of the glenohumeral joint. These muscles originate on the trunk and insert on the humerus. The biceps brachii and triceps brachii also are involved in glenohumeral movement. Primarily, the biceps brachii assists in flexing and horizontally adducting the shoulder, and the long head of the triceps brachii assists in extension and horizontal abduction.

Muscular activity is greatest during the service motion. Therefore, the serve can be considered the most strenuous stroke in tennis. In the loading phase of the serve, which puts the shoulder in maximal external rotation, there is moderately high muscular activity of the supraspinatus, infraspinatus, subscapularis, biceps brachii, and serratus anterior, highlighting the importance of scapular stabilization exercises as well as anterior and posterior rotator cuff strength exercises. The acceleration phase, which begins with maximal external rotation and ends with contact, features high muscular activity of the pectoralis major, subscapularis, latissimus dorsi, and serratus anterior. These muscles are very active during the forceful concentric internal rotation of the humerus. During the follow-through phase after contact, the posterior rotator cuff muscles, serratus anterior, biceps brachii, deltoid, and latissimus dorsi show moderately high activity to help create eccentric muscle contractions to slow down the humerus and protect the glenohumeral joint.

Tennis Strokes and Shoulder Movement

For a tennis player, the shoulder is one of the most used (and sometimes over-used) areas of the body. Typically, this makes it one of the most injured areas, especially in competitive tennis players. In addition to the repetitive demands on the shoulder, tennis also requires explosive movement patterns and highly intensive maximal-effort concentric and eccentric muscular work.

Groundstrokes require predominantly horizontal actions at the shoulder, using a combination of abduction and external rotation for the forehand backswing and backhand follow-through and a combination of abduction and internal rotation for the forehand forward swing and backhand backswing.

The tennis serve is a more complex sequence that uses a combination of horizontal and vertical movements. Horizontal abduction and external rotation occur during the backswing, with scapular retraction and depression into the loading phase. From the loading phase, scapular elevation, horizontal abduction, and shoulder extension move the arm toward contact. Internal rotation,

shoulder extension, and adduction complete the follow-through. The muscles of the rotator cuff play a vital role in stabilizing the humerus in the shoulder during all tennis movements, but they are critical during the acceleration and follow-through phases of the serve (figure 2.3). The muscles of the rotator cuff aid in power production during acceleration and provide eccentric strength to help slow down the arm after contact during the follow-through. It has been reported that during the explosive internal rotation of the serve, shoulder rotation can reach speeds from 1,074 to 2,300 degrees per second. After contact, deceleration has to occur through eccentric strength of the rotator cuff and

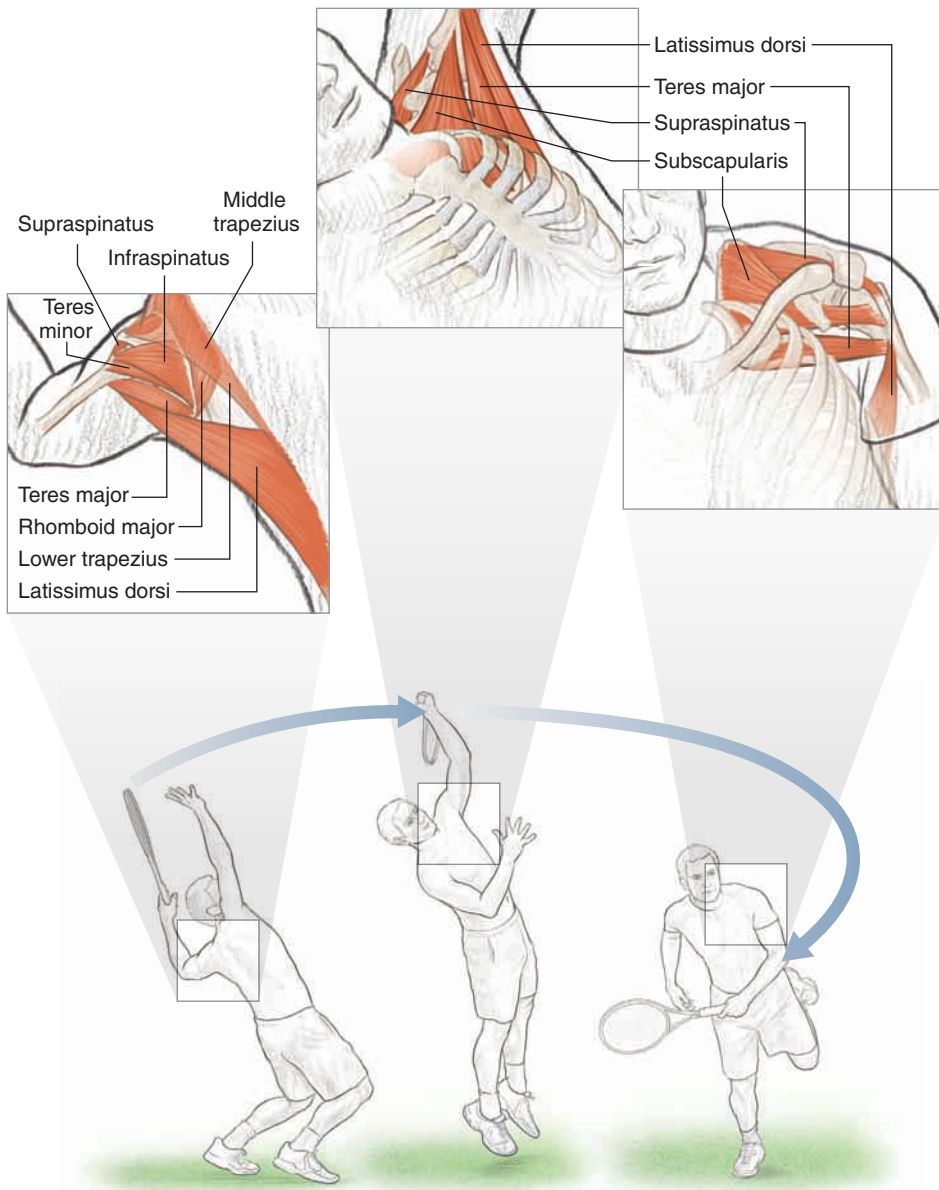


Figure 2.3 Changes in the humeral head during the serve.

related musculature. At the professional level, male players reach speeds on the serve close to 140 miles per hour (225 km/h). Proper preparation of the shoulder musculature is critical.

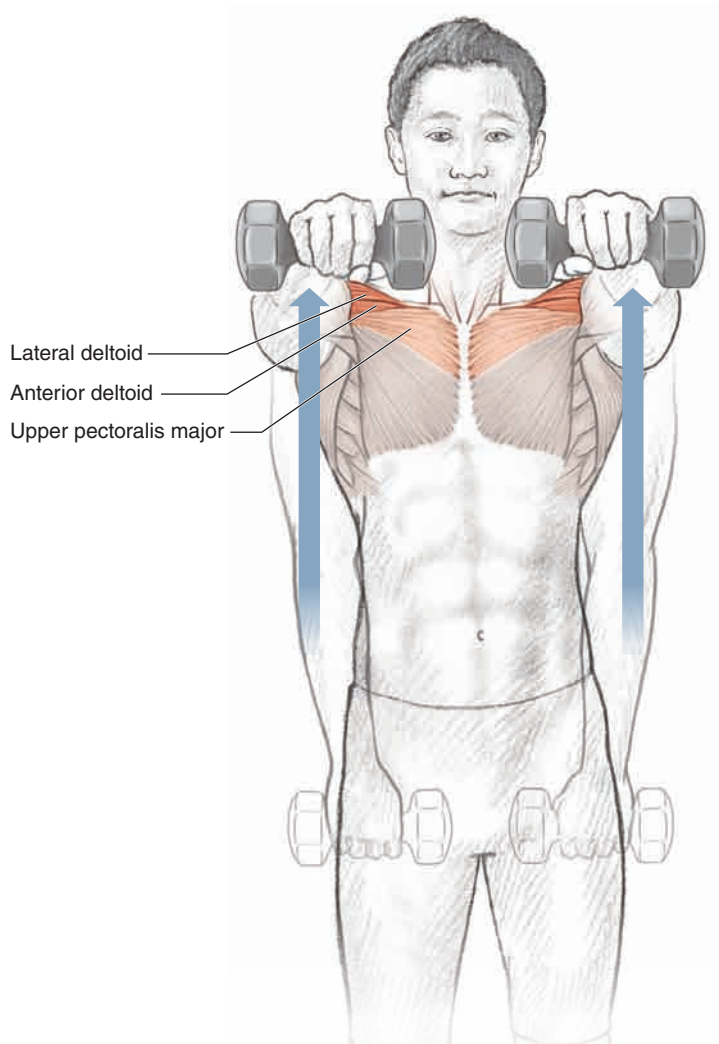
Tennis volleys require smaller muscle and joint movements than either groundstrokes or serves. For a forehand volley, slight external rotation and slight adduction followed by abduction of the shoulder allow the player to complete the stroke. The backhand volley involves slight internal rotation and abduction followed by slight external rotation and adduction of the shoulder.

Exercises for the Shoulder

The exercises that follow will benefit the shoulder joint. In particular, you will develop strong muscles surrounding the shoulder joint to both prevent injuries and enhance performance. While performing these exercises, contract the core muscles to develop a strong midsection. This will help with balance and posture as well as the transfer of forces from the lower to the upper body in each stroke. For exercises requiring resistance tubing, use a cable machine or attach the tubing to a stable object.

Although an exercise program should be highly individualistic, each exercise includes some general guidelines. An initial exercise program that includes the following exercises should include a proper balance between front and back and left and right sides of the body. We recommend starting with two or three sets of 10 to 12 repetitions until you have a strong base. Make sure you rest adequately between exercise sessions (at least one day) to help your muscles recover. Of course, the best training program is designed with your individual needs and performance goals in mind. Baseline fitness level, age, experience, and tournament schedule are all important factors. A certified strength and conditioning specialist with a good knowledge of tennis would be very helpful for designing a program as well as instructing on proper technique for each of the exercises.

Front Raise



Execution

1. Stand straight with your shoulders back, squeezing your shoulder blades together. Hold a light dumbbell (less than 10 pounds [4.5 kg]) in each hand. Rest your hands in front of your thighs, palms turned down. This is the starting position.
2. While keeping the arms straight, elevate both arms to shoulder height, palms down. Lift the arms to the front of the body, out in front of the chest. Hold the weights at shoulder height for two seconds.
3. Slowly lower the arms to the starting position and repeat.

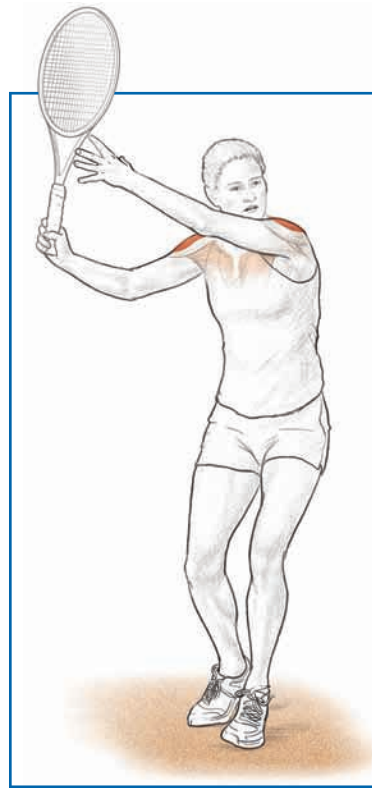
Muscles Involved

Primary: Anterior deltoid, lateral deltoid

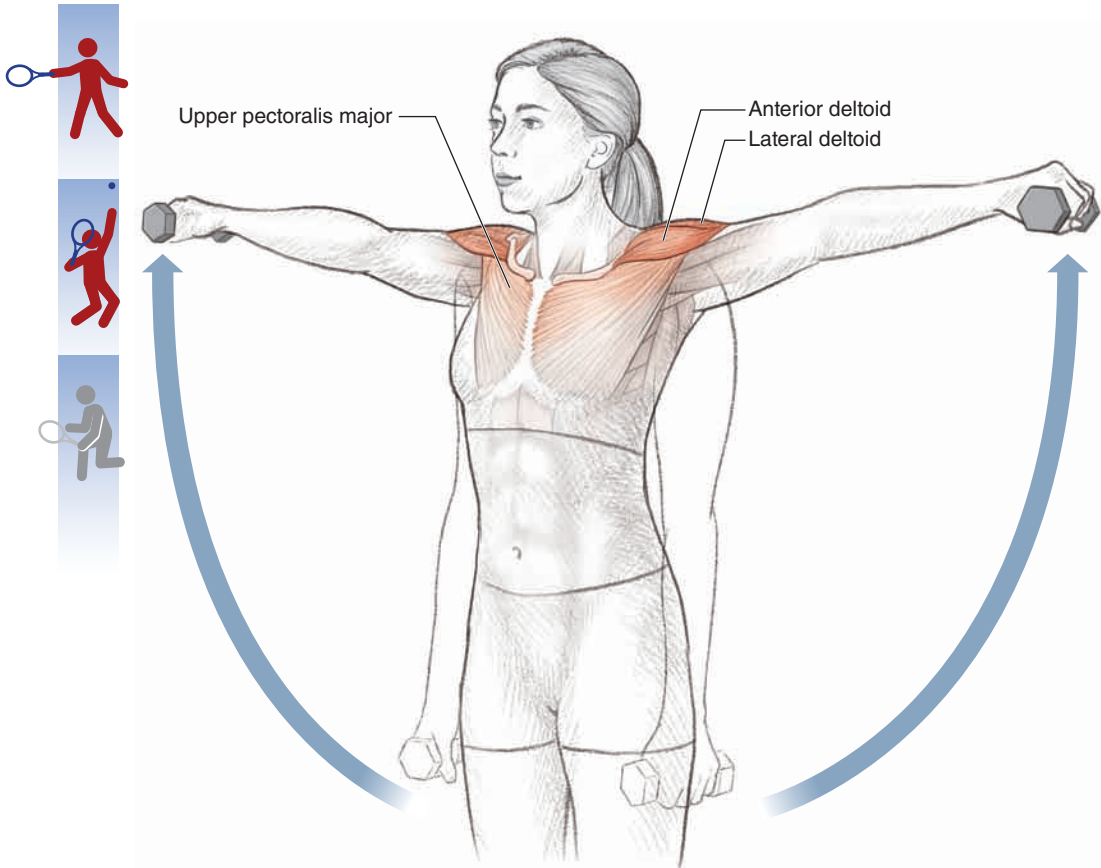
Secondary: Upper pectoralis major

Tennis Focus

The anterior aspect of the shoulder is a major player in elevating the arm on fore-hand groundstrokes, especially on high balls. It is important to develop the anterior aspect of the shoulder because this directly influences the acceleration aspects of the groundstroke and serve. A weak anterior portion of the shoulder will require the muscles, tendons, and ligaments of the biceps and pectorals to perform more work than is necessary, and this could result in injury.



Lateral Raise



Execution

1. Stand straight with your shoulders back, squeezing the shoulder blades together. Hold a light dumbbell (less than 10 pounds [4.5 kg]) in each hand. Rest your hands on the outsides of your thighs, with palms facing your thighs.
2. While keeping the arms straight, elevate both arms out to the sides (abduction), bringing the weights to shoulder height while keeping the palms turned down. Maintain firm wrists and straight arms. Hold for two seconds.
3. Slowly lower the arms to the starting position and repeat.

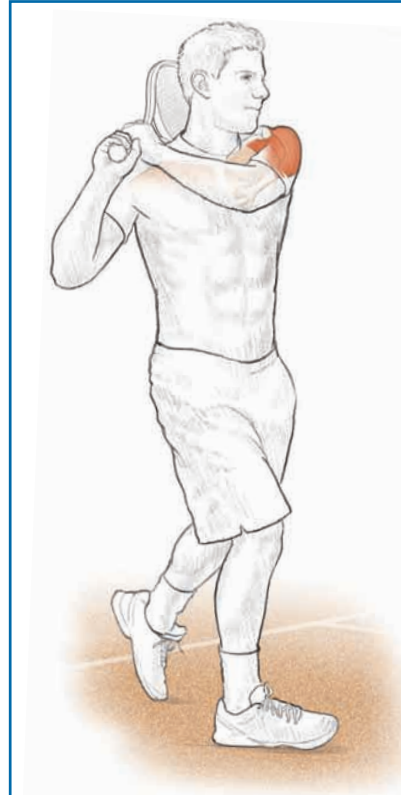
Muscles Involved

Primary: Anterior deltoid, lateral deltoid

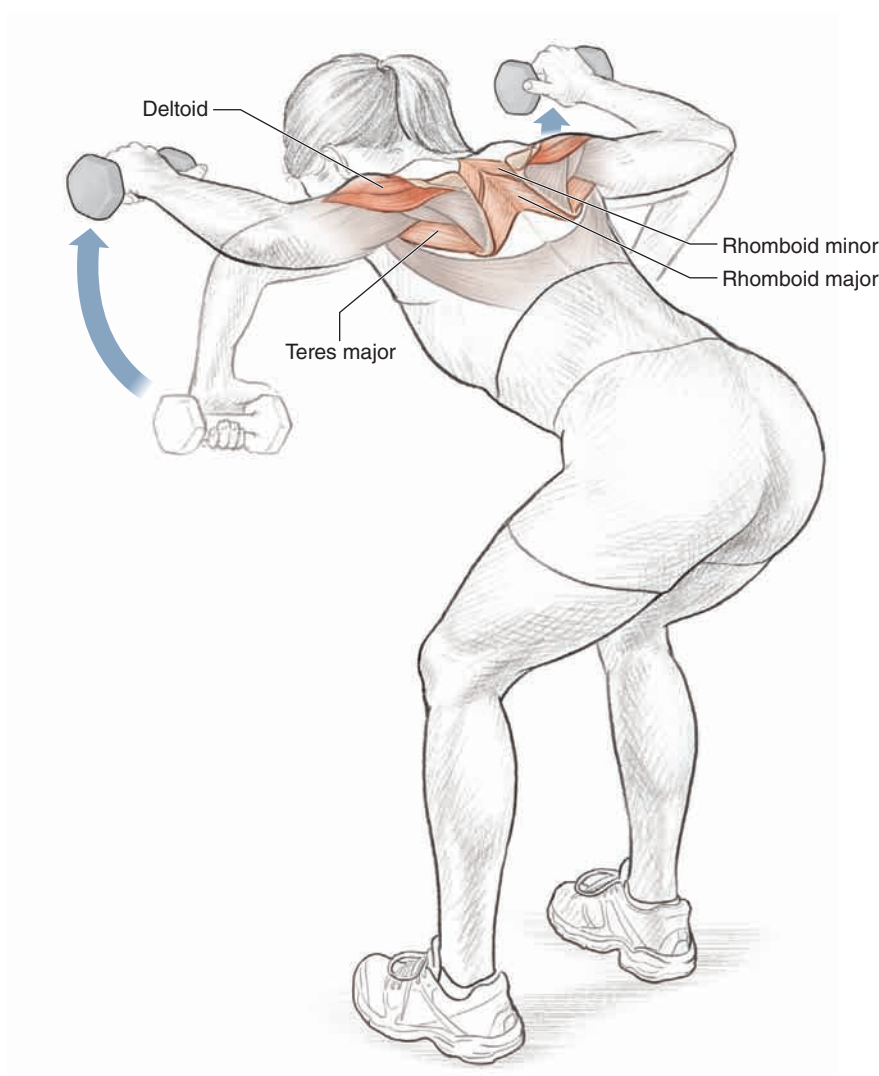
Secondary: Upper pectoralis major

Tennis Focus

The lateral aspect of the shoulder region, specifically the lateral portion of the deltoid muscle, is important in all movements requiring the arms to abduct away from the body. This is a component seen during tennis strokes, specifically in the backhand groundstroke from the end of the backswing all the way through the follow-through. Although the rotator cuff muscles help stabilize the shoulder joint during tennis strokes, having a strong and fatigue-resistant deltoid muscle will help protect the shoulder even more. It is especially important for those who use a one-handed backhand stroke because the lateral deltoid is one of the major muscles involved in both the acceleration and deceleration aspects of the stroke. The lateral deltoid also is important during the backswing component of the serve as the arm is in abduction.



Bent-Over Rear Raise



Execution

1. Stand with the feet shoulder-width apart. With a slight bend in the knees, flex at the waist while keeping the back straight. Hold a light dumbbell (less than 10 pounds [4.5 kg]) in each hand. Extend the arms toward the ground, palms turned down. Bend the elbows to about 90 degrees, knuckles toward the floor.
2. While keeping an approximate angle of 90 degrees at the elbows, slowly raise the forearms, leading with the dumbbells, to shoulder height. Hold for two seconds.
3. Slowly lower the arms to the starting position and repeat.

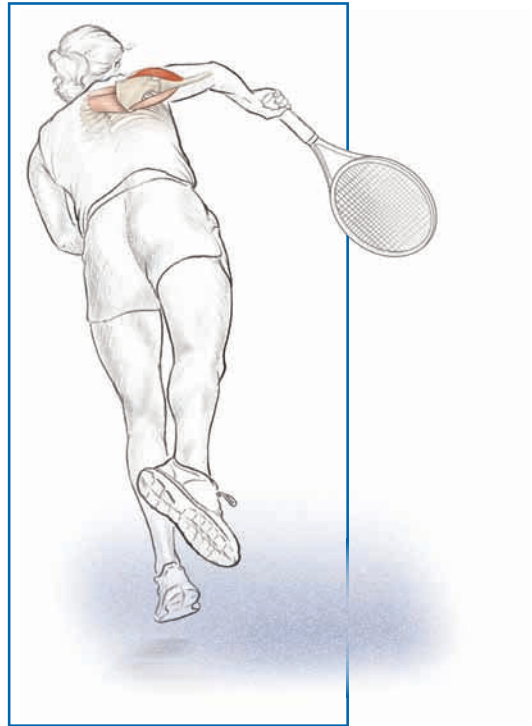
Muscles Involved

Primary: Deltoid

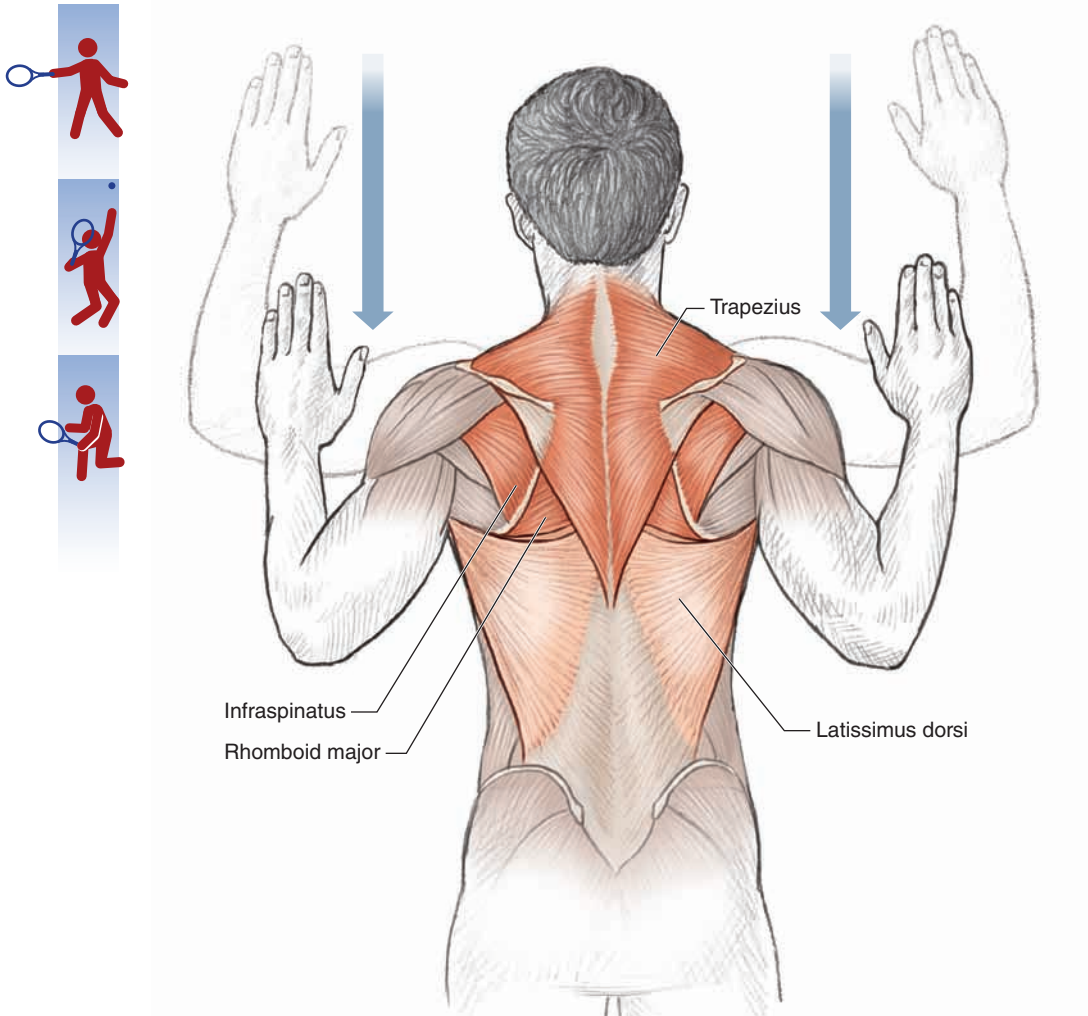
Secondary: Teres major, rhomboid major, rhomboid minor

Tennis Focus

The posterior aspect of the shoulder is a major player in decelerating the arm after a tennis stroke. It is necessary in all strokes, but the greatest forces are seen in the deceleration of the arm after ball contact in the serve. It is important to have adequate strength in the muscles at the back of the shoulder. This will aid in the development of strength in a movement that directly correlates with the backhand groundstroke. Squeezing the shoulder blades together (retraction) at the top of the movement activates the rhomboids to a greater extent, which helps develop appropriate scapular control and prevent shoulder injuries.



Elbow-to-Hip Scapular Retraction



Execution

1. Stand erect with feet shoulder-width apart and knees slightly bent, with a 90-degree angle at the shoulders and a 90-degree angle at the elbows. This is the starting position.
2. Slowly lower the elbows toward the hips in a controlled manner by contracting the rhomboids in the upper back. Hold at the bottom of the movement for two to four seconds.
3. Slowly raise the arms to the starting position and repeat.

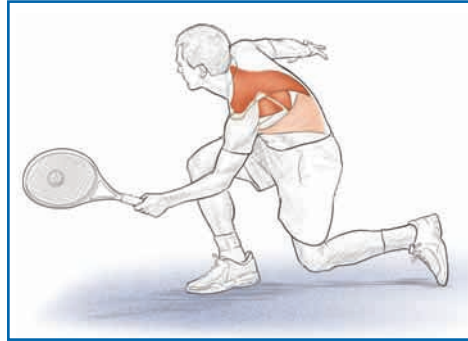
Muscles Involved

Primary: Trapezius, infraspinatus, rhomboid major, rhomboid minor

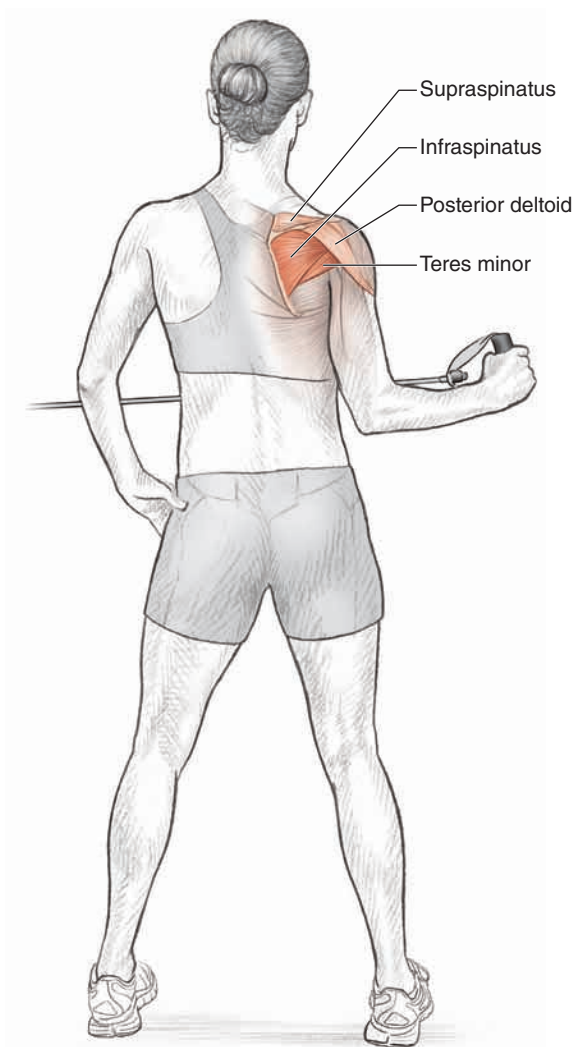
Secondary: Latissimus dorsi

Tennis Focus

Scapular position plays a role in an athlete's risk of injury. The elbow-to-hip scapular retraction exercise is focused on the muscles that are involved in maintaining good scapular position. This exercise is a posture-predominant movement and is particularly important because many tennis players have weaker than required scapula-stabilizing musculature. The focus of this exercise is to strengthen the muscles involved in stabilizing the scapula, which will not only aid in the prevention of injury but also allow for more efficient stroke mechanics, resulting in greater power production on tennis strokes. Apart from improving posture, this exercise directly stimulates muscle contractions similar to those experienced during the loading phase of the serve and also during forehand volleys with a close contact position.



External Rotation



Execution

1. Stand sideways and grab the resistance tubing with your outside hand, your elbow close to the hip at a 90-degree angle and your forearm parallel to the floor. This is the starting position.
2. Slowly rotate the shoulder externally (away from the body) against the resistance from the tubing, making sure the forearm remains parallel to the floor. Maintain your shoulder position, and do not rotate the waist during the movement. Hold near the end range of motion for two seconds.
3. Slowly return to the starting position, and repeat for 10 to 12 repetitions. Then perform the same movement with the opposite arm.

Muscles Involved

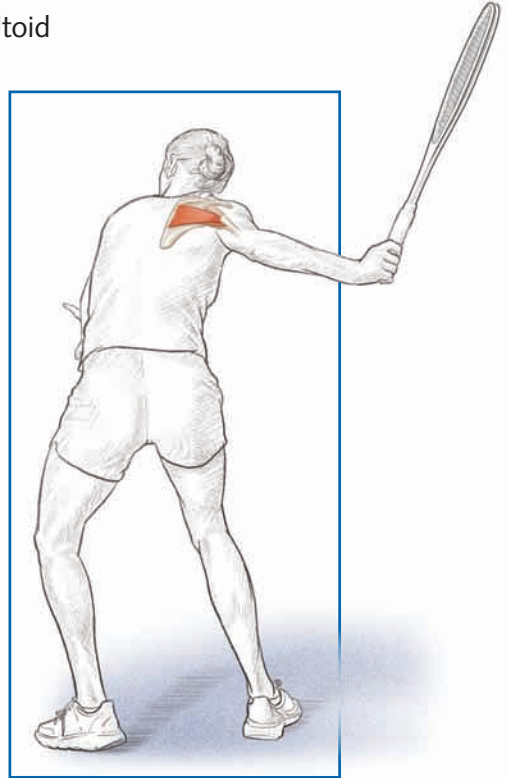
Primary: Infraspinatus, teres minor

Secondary: Supraspinatus, posterior deltoid

Tennis Focus

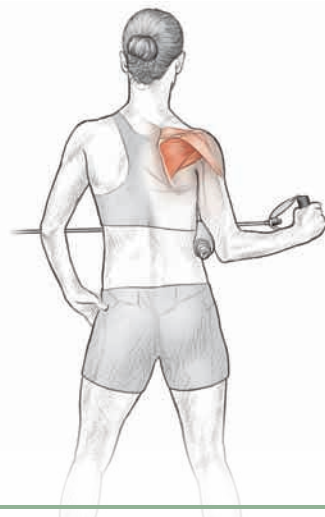
Rotator cuff strength and endurance are paramount for success in tennis, whether you want to hit serves at 130 miles per hour (210 km/h) or be able to endure a three-hour match without fatigue or pain. Train the rotator cuff muscles regularly to prevent injury and improve performance. The external rotation exercise focuses on the external rotators and is very important in decelerating the arm after ball contact. External rotation is a crucial factor in many tennis strokes, including the forehand backswing. During the backswing, the arm is abducted. A strong shoulder helps store potential energy to be released during the follow-through phase of the forehand.

Because this exercise is performed in the transverse plane, it is highly specific to improving deceleration after ball contact on groundstrokes. Having the appropriate strength to effectively decelerate the arm is important for preventing shoulder and arm injuries.

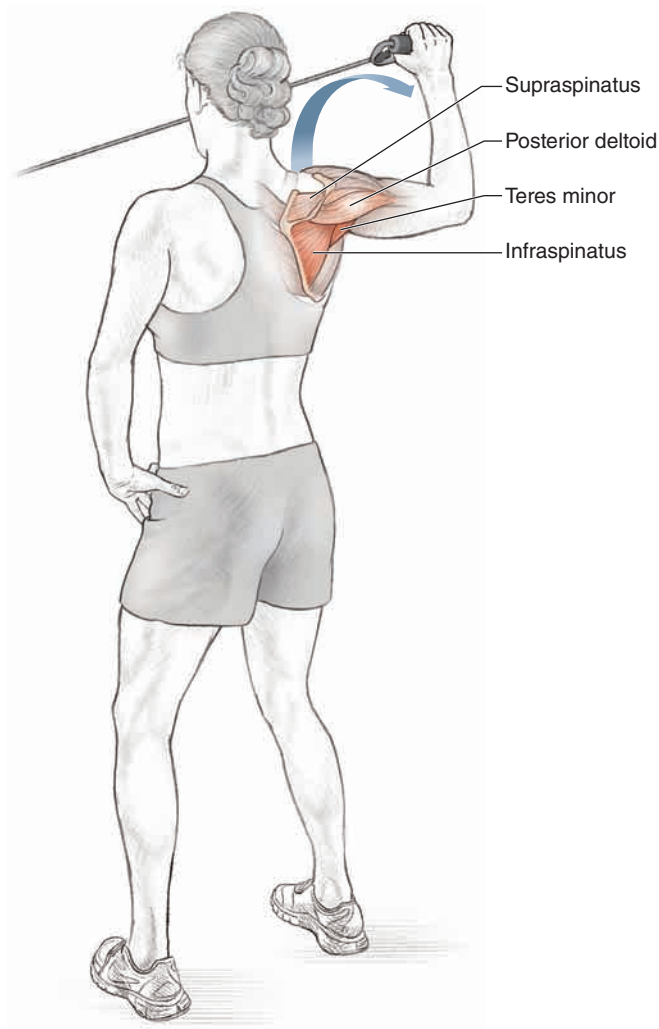


VARIATION

Place a towel between the elbow and side during the external rotation exercise. This creates a better position for performing the exercise and also increases the muscle activation of the posterior aspect of the shoulder—the infraspinatus and teres minor—by approximately 20 percent.



90/90 External Rotation With Abduction



Execution

1. Stand erect, feet shoulder-width apart, facing the tubing attachment. Grasp the resistance tubing at shoulder height with a 90-degree angle at the shoulder and a 90-degree angle at the elbow. This is the starting position.
2. Slowly externally rotate the shoulder against the resistance. The forearm starts parallel to the floor and is perpendicular to the floor at the top of the movement (external rotation at the shoulder). Hold near the end range of motion for two seconds.
3. Slowly return to the starting position, and repeat for 10 to 12 repetitions. Then perform the same movement with the opposite arm.

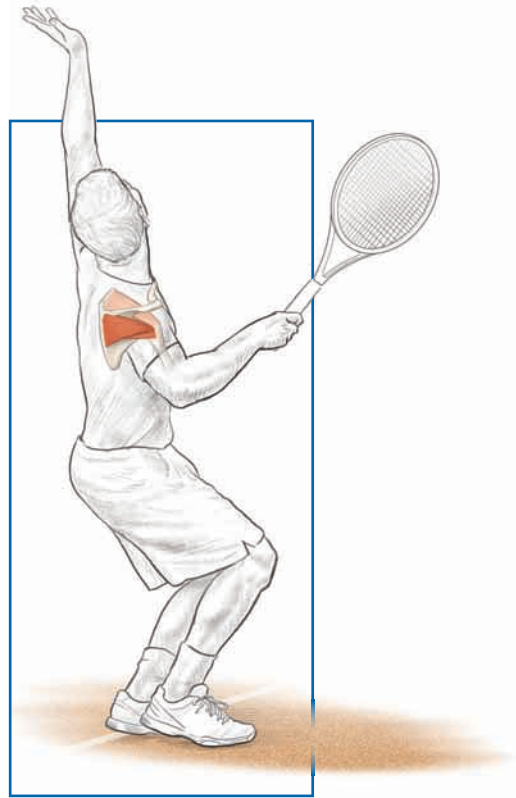
Muscles Involved

Primary: Infraspinatus, teres minor

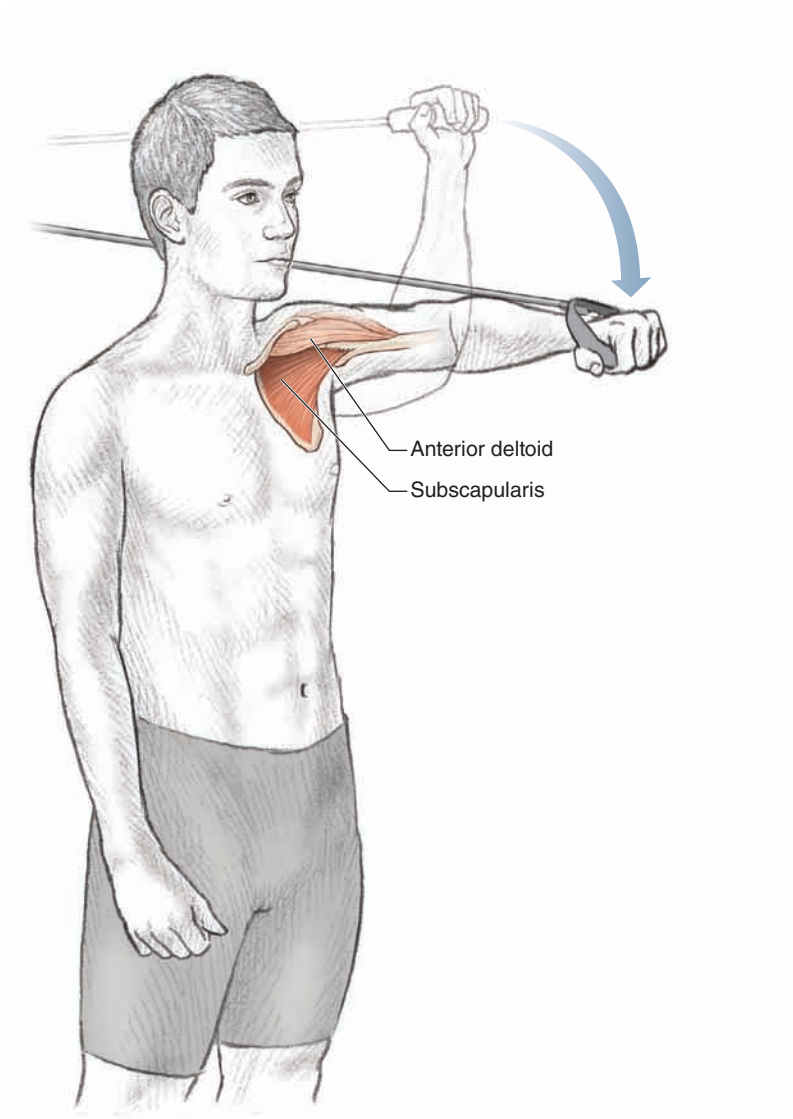
Secondary: Supraspinatus, posterior deltoid

Tennis Focus

Similar to the external rotation exercise, the 90/90 external rotation with abduction exercise focuses on the external rotators, which are very important in decelerating the arm after ball contact. Because this exercise is performed in the sagittal plane, it is highly specific to improving the ability to decelerate the arm after ball contact on serves. It also is important during the concentric contractions of the loading phase of the serve. This exercise requires good shoulder capsule stability and helps strengthen the muscles required to decelerate the arm after a serve.



90/90 Internal Rotation With Abduction



Execution

1. Stand erect with feet shoulder-width apart, facing away from the tubing attachment. Grab the resistance tubing at shoulder height, with a 90-degree angle at the shoulder and a 90-degree angle at the elbow. This is the starting position.
2. Slowly internally rotate the shoulder against the resistance. The forearm starts perpendicular to the floor and is parallel to the floor at the bottom of the movement. Hold near the end range of motion for two seconds.
3. Slowly return to the starting position, and repeat for 10 to 12 repetitions. Then perform the same movement with the opposite arm.

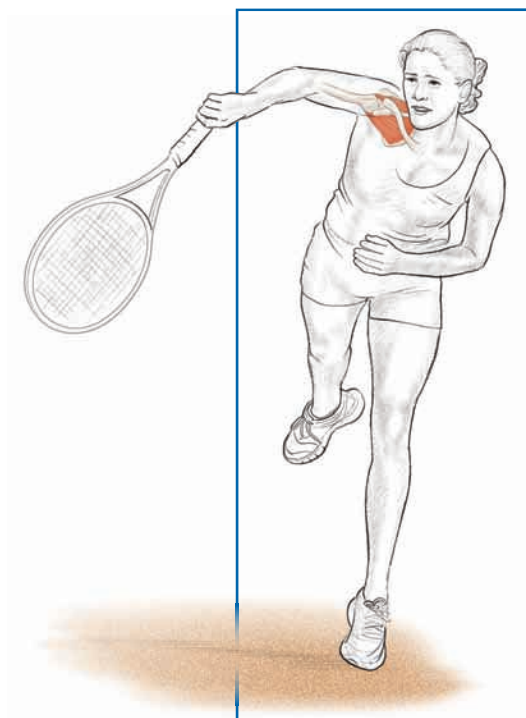
Muscles Involved

Primary: Subscapularis

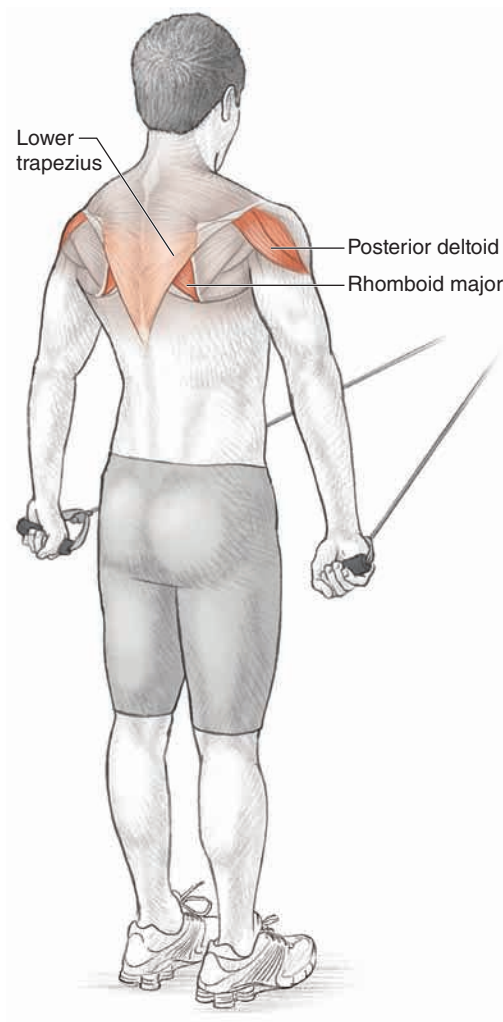
Secondary: Anterior deltoid

Tennis Focus

A strong rotator cuff is important in tennis, especially just before and during ball contact. The 90/90 internal rotation with abduction exercise specifically focuses on strengthening the smaller stabilizing muscles required to maintain shoulder position. Because this exercise is performed in the sagittal plane, it is highly specific to improving the strength of the stabilizers during the acceleration phase of the serve. This exercise will increase the speed of the serve as the player's capability to produce power improves throughout the contact and follow-through phases of the serve.



Low Row



Execution

1. Stand erect and face the tubing attachment. With your arms low and in front of you, grasp the resistance tubing in each hand. Activate the rhomboids by squeezing the shoulder blades together.
2. Slowly push your hands back against the resistance while keeping your arms straight. Maintain a stable wrist position. Hold near the end range of motion for two seconds.
3. Slowly return to the starting position and repeat.

Muscles Involved

Primary: Posterior deltoid, rhomboid major, rhomboid minor

Secondary: Lower trapezius

Tennis Focus

Tennis players must be well balanced in their muscular development. The low row exercise focuses on the muscles of the upper back and posterior shoulder that are typically undertrained in tennis players—the posterior deltoid, rhomboids, and even the lower aspects of the trapezius. The low row helps prevent injuries and strengthen the vital muscles used to help the upper body decelerate after a powerful groundstroke or serve. These muscles are also active concentrically in the acceleration phase of the one- and two-handed backhand. Another benefit of the low row exercise is improved scapular position and shoulder alignment at rest. Proper posture limits the likelihood of shoulder impingement-related pain, tightness, or weakness in the anterior aspect of the shoulder and chest muscles. Shoulder impingement, specifically at the front of the shoulder, results in pain and potentially reduced stroke speed. Long-term impingement can result in more severe injuries that may require surgery. It is important to improve shoulder posture to prevent these injuries.

