

# What a racket!

## Racket Sports Injury Prevention

By Tamara Mitchell



Tennis, racquetball, squash and badminton are all great sports, providing an excellent total body workout with cardiovascular benefits...and they are FUN! Racket sports were found to be the top athletic activity for reducing the risk of mortality and cardiovascular death.<sup>1</sup> One study found a whopping 47% lower risk of death during the 9-year study and 56% less risk of death from cardiovascular disease.<sup>1</sup> Swimming came in second at 28% (overall) and 41% (cardiovascular) reduction respectively, with aerobics coming in 3<sup>rd</sup> at 27% and 36% reduction respectively.<sup>1</sup> Cycling also reduced overall mortality rate.<sup>1</sup> Cycling, running, and football (soccer) were studied and there was no significant reduction in cardiovascular death with any of these sports.<sup>1</sup> Tennis, swimming, and aerobics are superior in this regard because they are full body workouts which make the heart work harder. They also involve intense bursts of activity with brief periods of rest.<sup>2</sup> Research is showing more and more that short bursts of intense activity may be better than long slow cardio workouts possibly because your heart continues to work at an aerobic level, but the stress on the rest of the body is not continuous.<sup>2</sup>

As with any fast-paced, competitive sport, racket sports have many possibilities for traumatic and overuse injuries. For tennis, 2/3 of all injuries are overuse injuries while the other 1/3 are traumatic or acute injuries.<sup>3</sup> Overuse injuries primarily affect the shoulders, wrists, and elbows.<sup>3</sup> Understanding the primary ways people get injured during racquet sports allows players to prepare and protect themselves from injury and hopefully be able to play safely for many years. There are some people with pre-existing conditions who should avoid racket sports entirely.

### Precautions

Because of the high forces and repetition encountered by the wrist and forearm in racket sports,<sup>4</sup> *anyone with any type of pre-existing wrist or forearm issues should not play racket sports.* Even with strengthening exercises and excellent equipment and technique, racket sports increase strain and damage to muscles and tissues that are already injured from Repetitive Strain Injuries.

Racket sports are a form of vigorous exercise, not mild or moderate if you play with enthusiasm. If you have been leading a sedentary lifestyle, especially if you over 50, the level of intensity of exercise should be increased gradually.<sup>5</sup> Vigorous exercise provides great health benefits, but carries risks beyond mild or moderate forms of exercise. Consulting a doctor prior to engaging in these sports is advised especially if you have any of the following risk factors:<sup>5</sup>

- A symptom you have never told your doctor about
- Age over 50
- Arthritis
- Blood clots
- Chest pain
- Chronic lung disease
- Diabetes
- Eye injury or recent eye surgery
- Family history of a cardiovascular disease

- Foot or ankle sores that won't heal
- Heart disease
- Heart palpitations
- Hernia
- High blood pressure
- History of smoking
- Infections
- Joint swelling
- Overweight or Obesity
- Pain or trouble walking after a fall
- Pregnancy
- Sedentary lifestyle
- Shortness of breath

If you feel any of the following warning signs, seek medical help and do not ignore them as they are commonly felt prior to sudden death during strenuous exercise.<sup>5</sup>

- Irregular heartbeat
- Shortness of breath
- Chest pain
- Light-headedness or dizziness
- Fainting
- Unusual fatigue
- Nausea

### **Injury Prevention**

The keys to avoiding overuse and traumatic injuries in racket sports are:<sup>4,6</sup>

- Conditioning including weight and isokinetic training, and stretching
- Proper technique
- Proper equipment and court conditions
- Preparation and warm up prior to play
- Awareness during playing
- Cool down
- Rest and recovery days

In addition, one of the best ways to prevent overuse injuries is to allow adequate rest so your body can recover.<sup>7</sup> Periods of heavy training or lots of play need to be followed by rest to allow the body to adapt and grow stronger.<sup>7</sup> Training and amount of play should start at a lower level and progress gradually.<sup>7</sup>

#### ***1. Conditioning***

If you are out of shape, prepare your body by training several weeks before you start playing.<sup>8</sup> A poor fitness level increases your risk for injury, so get fit to play racket sports; don't play to get in shape.<sup>8</sup> If a person simply plays tennis to get fit, there will be uneven development of various body parts resulting in imbalances and setting the player up for injuries of all types, but especially overuse injuries such as tennis elbow and rotator cuff injuries.<sup>8</sup>

Racket sports conditioning needs to involve several different types of training: strength, power, speed, coordination, agility, flexibility, and endurance.<sup>9</sup> In addition, because racket sports involve the dominant arm and repeated asymmetrical movements, there can be overdevelopment of muscles on one side of the body, imbalances, and muscle strains on the non-dominant side of the body.<sup>6</sup>

Racket sports are different from many other sports because it requires short bursts of speed, so improving your endurance by just running or cycling won't be as effective as doing sport-specific conditioning.<sup>9</sup> By following guidelines in training, you can prepare your body for the demands of racket sports, reduce the likelihood of all types of injury including overuse injuries.<sup>9</sup>

### Types of Training

- **Flexibility.** As we discuss in our article “The Great Stretching Debate”, stretching prior to exercise does not prevent injury and it actually leads to a decrease in performance, so when striving to improve flexibility in racket sports, it is important to understand when, why, and how stretching should be performed.<sup>9</sup> There are three types of exercises that are performed to increase flexibility:
  - *Dynamic stretching* involves moving various parts of the body to increase reach, speed, or both. This should not be confused with ballistic stretches which often causes injury through bouncing beyond the range of motion. Dynamic stretching improves flexibility of the body during motion and it is done as part of the warm-up to increase body and muscle temperature, intramuscular blood flow, and preparing the body for specific motions to be made during the game.<sup>9</sup> This video shows a good warmup with dynamic stretching that takes just 10 minutes to perform and will prepare the body for play: <https://youtu.be/ZwCf1xiS1zc>
  - *Static stretching* involves slowly and gently stretching the muscle until there is very slight discomfort and holding it for 15-20 seconds.<sup>9</sup> The muscle should be held until the tension in the muscle releases and it is possible to stretch a bit farther.<sup>9</sup> This type of stretch is the most widely used type of stretch and it should be done after exercise when the body is warm or in the evening so that performance will not be affected.<sup>9</sup> Static stretching can increase range of motion, but it has not been shown to improve the dynamic flexibility required for racket sports.<sup>9</sup>
  - *Proprioceptive neuromuscular facilitation (PNF)* involves a combination of isotonic and isometric muscle contractions.<sup>9</sup> In addition, isotonic muscle exercises involve concentric contractions where the muscles shorten as they work, or eccentric, where muscles offer resistance to movement as they elongate. Isometric contractions involve no movement nor muscle length changes, but they involve voluntary static contractions of the muscle.<sup>9</sup> Studies have shown that *PNF can improve flexibility more than any other stretching technique and at the same time improves muscle strength*, so is likely the best method to reduce injury.<sup>INF</sup> PNF generally require a coach or trainer to assist in the stretches, they must be performed while focusing and motivated, and they are more complex and intense than other types of stretches.<sup>INF</sup> For this reason, they are usually less popular than other types of stretches. The most popular and probably the most beneficial PNF stretches are called contraction-relaxation and they involve the trainer moving a limb until the end of range of motion is reached at which point the player contracts the stretched muscle isometrically against resistance provided by the trainer for 5-10 seconds.<sup>9</sup> This video shows a demonstration of how to properly stretch the hamstring using PNF techniques. <https://youtu.be/HpatAJI0-pU>
- **Speed and Agility.** Racket sports require quick reactions and changes of direction, so combining speed and agility training works perfectly.<sup>9</sup> Where speed involves fast reactions, quick starts and stops, decelerates to hit the ball, and constant motion, agility involves precision, coordination, efficient and relaxed movements to preserve energy, and reliability of motor control.<sup>9</sup> This video shows some excellent drills for improving speed and agility for footwork used in tennis. <https://youtu.be/ay8Qyx1QIcU>
- **Power.** Overcoming inertia of the player's own bodyweight when taking the first step or in quick direction changes are what power refers to in tennis.<sup>9</sup> Power and strength are both important. A player can be strong, but they will only be powerful when they can effectively apply that strength to hit the ball. Plyometrics are exercises that enhance the explosive forces using the whole lower extremity in larger movements than those developed during speed and agility training.<sup>9</sup> The plyometric drills that are effective for tennis are centered on reducing ground contact time.<sup>9</sup> Skills

such as jumping really high are not usually needed in racket sports, so that type of plyometric training is not necessary. This is an excellent video of plyometric exercises to start learning. Plyometrics are a very intense workout, so take frequent breaks to catch your breath! <https://youtu.be/Nt87Kr2oI2A>

- **Strength.** Strength training for tennis involves stabilization of the muscles and systems that support every joint. Both core strength, which stabilize the connection between the upper body and lower body, and joint stabilization, especially of the shoulders, hips, and ankles are important.<sup>9</sup> Because tennis is such a repetitious, dynamic sport, a high repetition/low weight routine is recommended in joint stability exercises (not core) to condition the muscles for the endurance and type of contractions necessary for tennis.<sup>17,8</sup>
  - Core and joint exercises need to be performed with perfect alignment and with great attention. The better trained these muscles are, the more efficient the transfer of energy throughout the body will be, resulting in a quicker, more powerful player and a body less likely to suffer injury.<sup>9</sup> A strong core will also help prevent lower back strain and injury.<sup>10</sup>
    - This 20 minute video shows an excellent core workout with Joanna Soh using the Swiss Stability Ball: <https://youtu.be/IJyEI8S05MI>
    - These quick exercises will help improve core and lower back strength: <https://youtu.be/O8YfHQBgxNM>
  - Shoulder strengthening and stabilization is important to prevent injury for all players. These exercises should be performed twice a week, not prior to playing tennis or other racket sports because muscles will be fatigued. There are several demonstrations of shoulder exercises online, but these two are very complete with excellent instruction on form from Performance Health Academy Network:
    - Part I - <https://youtu.be/E7aHXiTld-Y>
    - Part II - <https://youtu.be/XUMFDbMH2NM>
  - Hand and wrist strengthening should be done on days when other hand and wrist activities are not performed. That would preclude playing racket sports and any other activities that require the hand and wrist such as playing musical instruments, gardening, cooking, use of computers or handheld devices, or any other task or activity that will tax the fatigued muscles. Weight or resistance should be just enough so you feel a bit of fatigue by the end of the repetitions. Be especially careful to follow the instructions on the ball squeeze by using a flat tennis ball, not a new ball with a lot of resistance. This video has some excellent strengthening and stretching routines for the wrist, forearm, and hand with former tennis pro Neha Uberoi: <https://youtu.be/AkhoaFBBVGk>
  - Exercises for the legs emphasizing movements that are not only straight ahead and backward, but lateral and contra-body, are important to strengthen the legs, gluteus, hamstrings, and quadriceps muscles as they are used in racket sports such as in this video: [https://youtu.be/6f\\_E9iHo8rY](https://youtu.be/6f_E9iHo8rY)
  - Exercises targeting the hips, knees, ankles, and toes will keep them healthy and strong also. Start by doing the following exercises and determine which side is weaker.<sup>11</sup> Exercise *only the weaker side* once every day. Test yourself periodically and when the weaker side is equal to the stronger side, then exercise both legs until you reach the desired strength. To maintain strength, do the exercises twice a week.<sup>11</sup> These are excellent exercises for stability and injury prevention to the hips, knees, and ankles: <http://nismat.org/patients/injury-prevention/exercise-programs/lower-body-strengthening-program>
- **Endurance.** Endurance training is intended to build stamina and the ability to play at a peak level for longer periods. Three types of aerobic/anaerobic endurance training are described below.
  - Traditionally, endurance training has involved sessions of continuous training, or long training sessions of aerobic activity such as running for 30-60 minutes 3 times a week.<sup>9</sup>
  - An alternate type of aerobic workout also advised by the International Tennis Foundation is intensive continuous training or HICT (high intensity continuous training) which are repetitions of an intense, explosive exercise (such as step-ups with a loaded vest) at a slow,

- steady pace for a few seconds up to a few minutes, with a rest period of 5 minutes, then another round of intense exercise and a rest break.<sup>12</sup> HICT sessions last about 20-30 minutes total and should only be done twice a week to avoid the risk of overtraining.<sup>9</sup>
- A more recent type of workout called HIIT (high intensity interval training) involves exercising for short periods of very intense activity performed at 80% to 100% of maximal oxygen consumption, heart rate, or power output followed by recover intervals that involve little or no activity (Tabata training), or an active recovery period at 50% to 70% maximal effort (turbulence/power interval training).<sup>13,14</sup> This video shows a 15-minute HIIT workout that requires no equipment: <https://youtu.be/ODSrudz6IVY> Recent research comparing HIIT and Continuous Endurance Training has shown that in most measures of endurance, HIIT is comparable or superior including cardiovascular and maximal oxygen consumption (VO<sub>2</sub>max), improving heart stroke volume and heart rate recovery, increasing anaerobic threshold, skeletal muscle improvements, and improvements in metabolism of fat for fuel during exercise.<sup>13,15, 16</sup> Reference 15 has a description of tennis-specific HIIT training that can maximize physical results in less time. In contrast, this link ([http://www.itatennis.com/Assets/ita\\_assets/pdf/USTA/Sample+Conditioning+Plan.pdf](http://www.itatennis.com/Assets/ita_assets/pdf/USTA/Sample+Conditioning+Plan.pdf)) shows a 25-week conditioning plan for college tennis players that is a combination of HIIT, continuous training, strength, agility, and power training. The risk of injury, especially overuse injury and overtraining is higher with HIIT training, so gradual phasing into more HIIT training and not performing HIIT more than 3 days/week is important.

## **2. Technique**

Poor technique puts unnecessary strain on joints and muscles and is the number one cause of tennis injuries.<sup>17</sup> Stroke and form analysis can eliminate potential sources of injury.<sup>17</sup> If you have never taken lessons from a professional instructor, there is a very good chance you are practicing poor technique. It is harder to break bad habits than to learn proper technique at the beginning and it is impossible to play the game and observe yourself to analyze your stroke objectively. If you are just learning the sport or if you are starting to feel some twinges of pain, now is the time to seek some guidance on improving your form, technique, and even possibly your equipment. There are so many aspects to good technique we cannot cover them all here and we are not tennis experts, but we discuss some critical points below and give links to YouTube videos made with top instructors.

The motion of racket sports requires rhythm, timing, and sequential movement, transferring force smoothly from the ground upward.<sup>17</sup> Many beginners watch tennis on TV or on the courts and they think that players are using great strength in their arm to swing the racket.<sup>8</sup> Proper form and technique uses strength from the whole body, not just the arm, and by both strengthening the whole body rather than just the arm, there is the possibility of both greater power and less chance of injury to the arm.<sup>8</sup> If there is a "kink" in this smooth transition or if the player doesn't take advantage of the power of the lower body, additional force is required to hit the ball hard enough.<sup>17</sup> Timing is also important; a pause in continuous motion adds extra force throughout the body.<sup>17</sup> In this video, instructor Florian Meier demonstrates the concept of the kinetic chain during the tennis forehand swing: <https://youtu.be/7Lq7Io2nHh8>

This video shows instructor Mauro Marcos as he analyzes the stroke mechanics and body positioning of a player who has been experiencing knee and elbow pain. With proper technique, the strain is removed from twisting the knee and the most powerful part of the swing is used when impacting the ball so that the energy is transferred from the palm of the hand to the ball rather than jarring the arm and elbow, and requiring added strength of the arm to generate forces to the ball. By using the power of the kinetic chain, energy flows through the body to the racket, to the ball in a smooth motion that then releases following the hit. [https://youtu.be/4ZV7LVrRq\\_8](https://youtu.be/4ZV7LVrRq_8)

These YouTube channels and websites have many excellent videos by coaches who can explain not only proper technique, but why it is important, but we emphasize again that a personal coach is the only way to perfect your specific stroke and technique:

- Tennis Instructor Mauro Marcos and Coach Kyril: <https://www.youtube.com/user/CoachKyril/videos> and <http://thetennisvault.com/>
- Tennis instructor Florian Meier: <https://www.youtube.com/user/OnlineTennisLessons/videos>
- Squash instructor Nick Matthew: <https://www.youtube.com/user/squashskills/videos>
- Badminton coach Nghia Tran: <https://youtu.be/yaEfnpA9rus?list=PLA51499853A4146B8>

### ***3. Equipment and Court Conditions***

Good shoes are very important in racket sports. Shoes with a wide bottom accommodate the quick starts and stops, and the lateral movements that can cause ankle sprains. For added support, invest in support socks.<sup>18</sup> If possible, purchase shoes from a specialty store that is knowledgeable about the requirements of the sport and can help with proper shoe fitting.<sup>19</sup> Visit the store after playing the game when your feet are largest.<sup>19</sup> Wear the socks you normally wear and fit the shoe to the largest foot.<sup>19</sup>

The following are characteristics necessary in a good racket sport shoe:<sup>5,17,19</sup>

- Stability on the outside and inside of the shoe is very important for the quick side-to-side movements of the game.
- Flexibility in the sole at the ball of the foot allows quick forward movements.
- Shock absorption is somewhat less important in racket sports.
- Insole support to provide optimal foot support and cushion.
- Wide, padded toe box that allows the toes to spread sufficiently. You should be able to wiggle your toes.
- Snug heels with cushioning.
- Optimal tread pattern that is suitable for the surface. A small, shallow tread pattern is desirable for tennis played on a clay court. A wide tread pattern with deep flex grooves is best for a hard court.
- On soft courts, wear a shoe with a softer sole that allows better traction.
- Always re-lace the shoes when you try them on. Apply even tension from the farthest eyelets and use a crisscross lacing pattern to the top of the shoe.

#### Racket grip.

Both grip size and grip techniques are extremely important to prevent hand and wrist injury. The grip for tennis, badminton, squash, and racquetball are somewhat different from each other.

- This video by Florian Meier describes the forehand and backhand grips for **tennis**: <https://youtu.be/eRCWkQfPGvg>. And in this video, Mauro Marcos discusses how to hold the racket with your hand (not which grip to use): <https://youtu.be/EJte9GmquFc>.
- Special attention is needed for the two-handed backhand as this is very often done incorrectly and is the source of a lot of elbow and wrist injuries. This video with Mauro Marcos shows the proper two-handed backhand for both right and left handed players: <https://youtu.be/IGlkvPal99A>. This video by coach Nghia Tran describes the proper grip on the racket for **badminton**: <https://youtu.be/2cnbHARo8nI>.
- This video with Shawn Royster describes the forehand and backhand grips for **racquetball**. **Squash** is virtually the same as for racquetball: <https://youtu.be/tMagHPhoRxA>.

It is important to remember that you should not have a death grip on the racket at any time, particularly between shots. It is very important to relax the grip to relieve tension on the hand, wrist, and arm muscles. This video by Nick Matthew discusses this concept with regard to squash, but it applies to all racket sports: <https://youtu.be/oG5jig49nBk>. And in this entertaining video, instructor Mauro Marcos describes three things to do to play relaxed tennis: (1) Proper grip size, (2) Don't grip too tight, and (3)

Remember to inhale when you bring your racket back and breathe out when you hit the ball and don't hold your breath (for good oxygenation of the blood and to stay relaxed): <https://youtu.be/O3Qz9cAxUVE>.

- A grip that is too small often results in the inability to hold onto the racket adequately.<sup>17</sup> A grip that is too big often results in constant contraction of the forearm muscles for fear of losing grip.<sup>17</sup>
- A stiffer racket frame reduces vibration and dampens vibration more quickly.<sup>17</sup>
- Cushioned grip tape increases racket dampening by up to 100%.<sup>17</sup>
- Lowering string tension creates a trampoline effect which absorbs some of the shock from ball impact.<sup>17,20</sup>
- A tether will keep the racquetball racket from flying out of your sweaty grip and possibly hitting your opponent or yourself.<sup>2</sup>

**Ball characteristics.** In tennis, avoid using dead or wet balls because they require greater force to hit.<sup>21</sup> Tennis balls are tightly regulated, but there is some variation in the amount of bounce depending on the manufacturer, the temperature, the humidity, and other factors.<sup>22</sup> Manufacturers vary the materials used in the felt and the thickness of the rubber, and there are new balls with lower compression and bounce used to teach kids.<sup>22</sup>

Squash balls are very curious things. There are four basic squash balls, each with different abilities to bounce and the balls intended for advanced players require constant play and hard hitting to stay warm.<sup>23</sup> When an advanced-level ball has been played with hard, it actually feels hot to the touch and it bounces over twice as much as when it is cold.<sup>23</sup> It is nearly impossible for a beginner to play rallies long enough and hard enough to warm an advanced ball up, so if a player tries to play with a ball that is beyond their level, they will be playing with a ball that bounces far less than it should, they have to hit the ball harder than necessary and they don't really get a feel for the game as well



Illustration courtesy Ref. 24

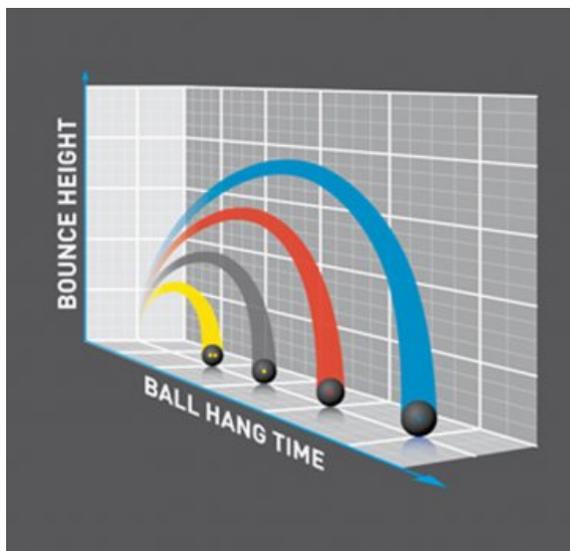


Illustration courtesy Ref. 23

as if they played with a ball that matches their ability. Playing with a ball that is beyond your ability level doesn't mean you are a better player; it makes you a worse player and opens you up to forearm injuries from hitting too hard. Beginner balls and intermediate balls have higher abilities to bounce, so the player gets to play with a ball that is much more alive and responsive.<sup>23</sup> Blue dot balls are perfect for beginners.<sup>23,24</sup> Red dot balls are good for somewhat experienced, recreational players.<sup>23,24</sup> Single yellow dot balls are good for more advanced players or for courts that are cool.<sup>23</sup> Double yellow dots are primarily for professional competition.<sup>23,24</sup> There are also smaller balls for kids and special balls for playing at high altitudes which significantly changes the bounce qualities.<sup>23,24</sup>

*Court conditions.* Avoid playing tennis or badminton on very hard surfaces such as asphalt or cement.<sup>18,25</sup> Lower back injuries are very common in tennis players who play on hard surface courts, but they can be reduced by wearing special heel inserts in the shoes to absorb the shock.<sup>18, 25</sup> Indoor badminton courts can be made of synthetic materials or wood, which reduce damage to the shin bone and feet.<sup>26</sup> Racquetball and squash courts are made of wood according to specifications set down by the International Racquetball Federation and the World Squash Federation.<sup>27,28</sup>

#### **4. Preparation and Warm Up**

The following guidelines are sufficient for amateur players who play a game or two daily or just occasionally. If you are a more serious player who participates in lengthy tournaments, more attention needs to be paid especially to diet. Refer to the International Tennis Federation's Nutrition guidelines if you participate in intensive and extended periods of play:

<http://www.itftennis.com/scienceandmedicine/nutrition/overview.aspx>

- Don't eat for 2 hours before vigorous exercise.
- Adjust your activity level according to the weather, and reduce it when you are fatigued or ill.
- Drink plenty of fluids before, during, and after a workout. For more information on proper hydration, please refer to our article on this topic: <http://working-well.org/articles/pdf/Hydration.pdf>
- Consider mixing up one of these healthy homemade sports drinks:

<p><b>Honey Citrus Sports Drink</b>            3 cups filtered water            ¼ raw unfiltered local honey            ¼ tsp unrefined sea salt            1/3 cup mixed lemon and lime juice            (or any other fruit juice)</p>	<p><b>Pomegranite-Cranberry Sports Drink</b>            2 cups Cranberry-pomegranite juice            1.5 packets Stevia powder            ¼ tsp unrefined sea salt            2 qts. water</p>
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Warm up the body with gentle motions of increasing intensity that approximate the motions of racket sports. This video shows the warm up exercises done by tennis pro Maria Sharapova prior to play. The purpose is to increase blood flow to the muscles she will be using prior to play which reduces the probability of injury to cold muscles. Note that she does not do stretching exercises and all of the warm up exercises are with very light resistance, not intended to strengthen the muscles. [https://www.youtube.com/watch?v=n\\_Eo1-cnPLE](https://www.youtube.com/watch?v=n_Eo1-cnPLE)

#### **5. Awareness**

Do not ignore cramps, pain or fatigue. Most major injuries happen when a player keeps playing after an injury. Be aware of your physical weaknesses and "listen" to what they are telling you. Respect your physical limitations and don't continue playing when you are fatigued.

In racquetball and squash, many injuries occur when one player is more experienced than the other. If you are more experienced, play with a ball that is rated for the least experienced player, tone down your shots and keep your guard up. If you are the less experienced player, do not take unnecessary chances and expect to defeat your opponent. Learn from your opponent's tactics and safety measures.

#### **6. Cool Down**

Allow 5 minutes to cool down by walking around until your heart rate returns to normal. Jumping into a shower or running out to the car right after a game can upset your body's sweating system.

## Overuse Injuries and Treatment

Many body parts are subject to overuse injuries in racket sports due to the high impact and repetitive motions required in these sports. Two-thirds of tennis injuries are due to overuse while the remaining injuries result from a sudden, traumatic event.<sup>3</sup> For this reason, people who have previous injuries should take adequate preventive measures to avoid re-injury. Players with a history of joint injury should seek medical advice on taping or bracing before playing. People who compete or play frequently are at high risk of overuse injuries.

Many overuse injuries are caused by too much or too intense training and playing.<sup>7</sup> The body is unable to cope with the stresses of the training load and injury results.<sup>7</sup> When recovering from injury, strengthening should be done only after tissues have started to heal, not before.

*Wrist.* In tennis, because the wrist is the last link in the kinetic chain as the ball hits the racket, incorrect movement earlier in the chain will cause problems in the wrist. Impact forces and repetition are also contributing factors of wrist injury.<sup>17</sup> For a while in the 90's coaches were teaching a wrist snapping technique in the forehand stroke during ball contact which was misinterpreted from some professional players.<sup>29</sup> In fact, the wrist should not snap when you are hitting the ball, but after hitting as shown in the illustration below, and discussed midway through the technique video by Mauro Marcos: [https://youtu.be/4ZV7LVrRq\\_8](https://youtu.be/4ZV7LVrRq_8).<sup>29</sup> Avoiding the wrist snap at contact and making sure contact is when the arm is in front of the body should reduce the potential for wrist and elbow injury, but it is often not the way amateur tennis players hit the ball.



Illustration courtesy Ref. 29

Racquetball and squash require a snapping motion of the wrist, so tendons and ligaments of the wrist are frequently injured.<sup>9</sup> DeQuervain's tendinitis, is quite common in racquetball and squash players.<sup>20</sup> Dequervain's is discussed in our article, "Repetitive Strain Injuries: Muscles and Tendons": [http://working-well.org/articles/pdf/RSI\\_muscles.pdf](http://working-well.org/articles/pdf/RSI_muscles.pdf). Squash players are prone to bursitis and tears in the fibrocartilage tissues of the wrist resulting in pain in the outside of the wrist.<sup>20</sup> The latter case is serious, so it is important to see an orthopedic doctor to determine the correct treatment.<sup>20</sup> Review of the player's stroke mechanics is essential in addition to treatment of the injury.<sup>20</sup>

*Elbow.* Tennis elbow, or lateral epicondylitis, occurs in 40% to 50% of average recreational tennis players, especially those over 30 years old.<sup>17,30</sup> It is the most common upper extremity injury to racquetball and squash players.<sup>9</sup> This painful inflammation of the soft tissue on the outside of the elbow starts as a pain or burning and/or weakening grip strength.<sup>30</sup> The pain is mild at first and gradually worsens as the strain and damage continues. This muscle helps stabilize the wrist when the elbow is straight and extend the wrist or bend it backwards.<sup>3,30</sup> It is the most-used muscle when the ball hits the racket.<sup>3</sup>

What to do:

- Stop playing tennis and give it a rest - the first step toward recovery since this injury is due to repeated microscopic tears in the tendon where it attaches to the lateral epicondyle.<sup>30</sup>
- Examination of technique and grip is important to identify causes of injury.<sup>3,9</sup>
- Excessive wrist snap during the serve can result in tennis elbow after many repetitions.<sup>17</sup>
- When a ball is hit off-center it can cause excessive rotation of the forearm. If done repeatedly, it may result in an overuse injury.
- Conventional grip position, optimal contact point, and effective timing of the lower links in the kinetic chain are often solutions to elbow pain.<sup>17</sup>

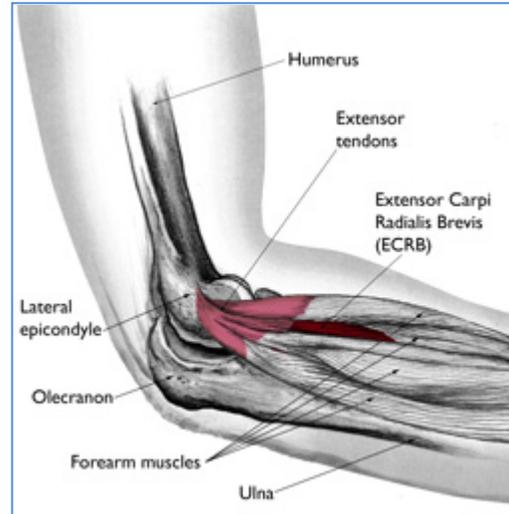


Illustration courtesy Ref. 30

- A stiffer racket frame and looser stringing will reduce stress on the forearm.<sup>30</sup> Very large head rackets increase stress on the forearm when the ball doesn't hit the sweet spot, so reducing head size may help.<sup>30</sup>
- Physical therapy including exercises, stretches, ultrasound, ice massage, or muscle-stimulating techniques to improve healing may be helpful.<sup>30</sup>
- There are lots of exercises on the internet and some may be harmful if you try to do them too soon in the healing process. At the same time, if you do nothing, the tendon may not heal on its own. We recommend the following video with reservations. Do not do any of these things if it causes you pain. What you want to do is to improve circulation to the area, gradually increase flexibility and range of motion, and gradually increase strength. If you have no pain, the exercises will help prevent injury by stretching and strengthening the muscles and tendons.<sup>3</sup>  
<https://youtu.be/uFNhIBR-Ae0> .

If symptoms don't subside in 6-12 months of treatment and rest, consult a health practitioner. Tendon damage can take a very long time to heal. Typical treatments of anti-inflammatories and ice may help with symptoms, but they will not help heal the tissues.<sup>31</sup>

*Shoulder.* Impingement is a common shoulder problem in tennis that can occur in racquetball, though rarely in squash because overhead shots are much less common.<sup>17</sup> Impingement is a narrowing of the space where the rotator cuff tendons and biceps tendon lie. When the arm is raised overhead the tendons may be constricted, causing pain and limited range of motion.<sup>17</sup> Overhead motions of tennis, especially while serving, and racquetball "ceiling rallies" can induce this problem.<sup>20</sup> Studies have well-documented the fact that the racket shoulder of tennis players loses internal rotation range of motion. This is a potential risk factor for overuse injury in the shoulder.<sup>17</sup>

Analysis of the strokes reproducing painful shoulder symptoms is important. The common strokes that may lead to shoulder impingement include the topspin forehand and the serve.<sup>17</sup> By finishing the topspin forehand with the dominant hand at or below the non dominant shoulder and focusing on generating force from the lower, larger, and stronger segments in the kinetic chain, the player may be able to eliminate the risk for shoulder impingement.<sup>17</sup> During the serve, reaching higher with the dominant shoulder to optimize racket height at ball contact may actually put the shoulder in an impingement position.<sup>17</sup> With the help of an instructor or coach, carefully analyze the timing and sequencing of the kinetic chain prior to the acceleration phase to determine the optimal contact point.<sup>17</sup>

Adequate strength and coordination of the shoulder girdle muscles is crucial to eliminating shoulder overuse injuries.

*Back.* Low-back strains and facet impingement syndromes are common injuries in tennis, racquetball, and squash.<sup>17</sup> Forces on the muscles and joints are the cause of many back injuries, especially during the cocking phase of the tennis serve when the spine is hyper extended and flexed laterally.<sup>17</sup> Rotation, side flexion, and extension of the lower back during the tennis serve places a lot of stress.<sup>10</sup> In all racket sports, both the forehand and backhand require a lot of trunk rotation and twisting.<sup>32</sup> Lack of lower back mobility and weakness of the core muscles are the two main risk factors in low back pain.<sup>10</sup> A stiff lower back will not be able to withstand the forces required as much as a flexible back.<sup>10</sup> Weak core muscles mean that the discs and joints of the back must take more of the load, and muscle spasms are more likely.<sup>10</sup> Strengthening the abdominals and trunk helps to support the spine and prevent back problems. Please refer to the Conditioning section of this article for links to excellent exercises that can be done to strengthen and increase mobility of the lower back and increase core muscle strength.

Warming up prior to play is critical to ensure that muscles are flexible and ready for the demands of the game.<sup>6</sup>

*Knee.* Overuse knee injuries are very common in racket sports due to the quick, repetitive and multidirectional movements made during play.<sup>17</sup> Patellofemoral tracking dysfunction and patellar tendonitis may be caused by biomechanical problems.<sup>17</sup> Inadequate strength or endurance of the quadriceps is often part of the problem.<sup>17</sup> Strengthening of the quadriceps as discussed in the Conditioning section of this article will help stabilize the knee and prevent injury.

For tennis, changing from hard to clay courts and limiting prolonged tennis play is recommended for knee rehabilitation.<sup>17</sup>

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