

Overuse Injuries

By Tamara Mitchell



The term Overuse Injury is generally used to describe one of several repetitive strain injuries that occur during exercise or sports. Overuse injuries are a result of repeated, continuous injuries to body tissues on a microscopic level.¹ This occurs when a cumulative, repetitive force is greater than a particular body tissue can withstand.¹ Body tissues can be gradually conditioned to be able to withstand greater forces by gradually increasing training loads, improving flexibility and strength, improving sport biomechanics or form, and sometimes by correcting anatomical misalignments.¹ Overuse injuries primarily affect the soft tissues of the body: tendons, ligaments, cartilage, and muscles.¹ Stress fractures to the bones are also included in overuse injury and are serious.¹

About half of all injuries in children and adults are a result of repetitive microtrauma or overuse, rather than a single traumatic event.¹ Examples of overuse injuries include tennis elbow, swimmer's shoulder, runner's knee, Achilles tendinitis, and shin splints.² Physiological or anatomical as well as external factors such as environment, equipment, or form can be part of the problem.¹ Anatomical issues appear to be a more prevalent factor in lower extremity overuse injuries than in upper extremity injuries.¹ Adolescents are more prone to overuse injuries because during the growth spurt, the bones elongate faster than the muscles resulting in lack of flexibility and tension in some areas of the body.¹ A fairly rare overuse injury unique to adolescents occurs where tendons and bones unite at the apophyseal growth plate which can end up resulting in excessive bone and cartilage overgrowth at these sites.¹

Preventing Overuse Injuries

Remodeling

The body is able to become stronger through exercise and adding forces to the bones, muscles, tendons, and ligaments beyond what is normal for everyday living.² Most people think about building muscle strength during exercise, but the bones, tendons, and ligaments also adapt to the addition of stresses or forces and can become extremely strong over time.² This process of building the strength of these tissues is called "remodeling". It involves both breakdown and buildup of these tissues. There is a balance between breaking down and building up that is very important. Tissues break down when they are stressed, then they rebuild when they are rested and stronger tissues replace the stressed tissues. When breakdown exceeds buildup, overuse injury occurs.²

Part of the healing process that occurs during remodeling is facilitated by sleep. Lack of adequate sleep is often overlooked in the prevention of injuries in sports, whether they are overuse injuries or traumatic injuries. It is essential that athletes get 8 to 9 ½ hours of sleep every night.³ It is well known that fatigue from lack of sleep often results in:³

- injury

- slower reaction times during sports also resulting in
 - higher injury rates
 - worse performance
- diminished concentration and focus
- reduced performance due to reduced cardiovascular performance

Correct Training

The most common overuse injuries occur because there is too rapid increase in the intensity, duration, and/or frequency of activity or exercise.² People who have been injured and are returning to exercise also may be easily reinjured if they go back to their previous routine without taking time to back up and rebuild their body, or if they push themselves too hard to regain the same level of activity as prior to the injury.²

Pre-season conditioning for sports is important because it develops the flexibility, endurance, and strength necessary to perform the sport and reduce the chance of injury.⁴ Research consistently has found that preseason conditioning and education are vital in preventing injuries.⁴ Conditioning should be designed with a specific sport in mind, if you are training for a sport.

Pace your progress. Most overuse injuries can be avoided by listening to your body and paying attention to aches and pains, not working through them and following the basic rule of increasing the level of intensity and duration by 10% or less per week.² This applies to the pace and mileage for runners, walkers, weight training, and essentially all other athletic activities.² Slowly building strength and endurance allows your body to rebuild and recover. Begin new activities or resume old ones with moderation. If you find yourself feeling too tired between workouts, back off and allow your body to heal before trying to force yourself to the next level. Reducing the number of consecutive days that you work out can reduce the chance of injury by allowing muscles and connective tissues a chance to rebuild.⁵ The use of pain killers such as Ibuprofen, aspirin, or Naproxen before or during athletic activities can mask pain which leads to increased risk of injury.⁶

Proper form and technique. We have pointed out in virtually every single article we have written that proper form is critical to preventing injury, especially overuse injuries. Form is not just about performance level at a sport, it's about aligning the body so that the flow of energy is smoothly transmitted without any jerking motions or strain to various body parts. Proper form and technique are critical and even minor changes in technique can make a huge difference in developing overuse injuries.² Working with a coach, trainer, or teacher can play an important role in preventing overuse injuries even if you are an expert, and especially if you are a novice.²

Wrist positioning is very important in many sports that use the hands and arms including racket sports, fishing, weight training, yoga, and ball sports. Make sure your wrist is in a neutral, straight position when bearing weight or upon impact. A wrist bent in any direction is weaker and it requires tendons, ligaments, blood vessels, and nerves to "turn a corner" while operating which invites strain injuries when motions are repeated many times or sprains when the motion involves a single overload event. It's also important to maintain a loose grip throughout the sport when a tight grip is not needed, tightening the grip only at the moment of impact. Hold the

racket, bat, or weight as loosely as possible. A continuous clenched grip causes unnecessary strain and fatigue.

Cross-train and broaden training. Adding strength training, increasing flexibility, and improving core stability also help reduce the risks of overuse injury.² But generally, variability in your exercise routine not only increases strength, power, agility, and the ability to perform multiple activities, it reduces the repetitive stress placed on the same body parts you use in your primary sport.⁷

Consistency means that you make time to train on a regular basis.⁸ Missing a workout now and then is OK, but missed workouts can add up and pretty soon, the regular habit of working out is lost and so are the fitness gains. Working out cannot be hit or miss. It has to be part of a regular lifestyle and daily routine.⁸ The point of regular training is that your body adapts to a new level of activity.⁸ This cannot be achieved through an occasional workout or through fast high-intensity workouts of short duration.

Do Warm Up...Don't Stretch. Always take time to warm up before activity.² Warm muscles and body tissues are much less likely to be injured and it's important to know that stretching your body when you have not warmed up can result in tears and strains. Please read our article "The Great Stretching Debate" which provides a lot of evidence and research to discourage people from static stretching prior to exercise. The days of recommending static stretching are over.⁴ Getting the blood flowing and gradually moving the body parts you will be using in dynamic motions is what you should be doing prior to exercise.⁴

Common dynamic and plyometric exercises include the following:⁴

- Warm-up: 1/2-speed jog, 3/4-speed jog, backwards jog and karaoke (watch this YouTube Video on karaoke: http://youtu.be/KOze-7t_-J0)
- Mild jog with high knees, skipping, butt kicks, and reaching to toes
- Lunges with twist and walking quad stretch
- Crawling calf stretch
- Simulating 3/4-speed sport-specific activities (plyometrics), such as bounding, hopping, and diagonal cutting.

Diet, weight control, hydration, and substance abuse

Good nutrition is very important in the maintenance of a healthy body. A diet with an appropriate balance of carbohydrates, preferably complex carbohydrates like whole grains, fats, proteins, and micronutrients provide the building blocks for a healthy body and help sustain blood glucose levels during exercise.^{9, 10} Inadequate caloric intake and dehydration can hamper performance, cause fatigue, and increase the odds of heat-related injuries.¹⁰ Being overweight puts extra strain on the joints, especially the weight-bearing lower extremities.¹¹ On the other hand, it's important to keep diet in perspective and not allow the pressures to maintain a particular body fat composition lead to eating disorders. Substance abuse among athletes includes overuse of alcohol, anabolic steroids, and cocaine, among other substances is a very real problem that is not healthy.¹² While anabolic steroids are used to improve performance, alcohol and cocaine are used for recreational purposes and can lead to reduced performance or even death.¹²

Anatomical Factors

Amateur athletes are rarely examined by a physician to determine anatomical misalignments prior to participating in sports as professional athletes are. If you are aware of misalignments that may predispose you to injury in your sport, since surgical correction is almost never recommended, it is possible to compensate through proper training, ergonomics, and environmental factors.¹ We are not going to cover the many anatomical problems that predispose individuals to overuse injuries in this article, but there can be imbalances between strength and flexibility around the joints, body alignment issues, predisposition to reinjury of previously injured body tissues (especially if they were not properly healed), or other anatomical factors.² If you or your children are planning to play a sport or participate in an activity extensively, it would be highly recommended that they be evaluated for anatomical issues. Such predisposition should not mean that a person cannot participate in a sport, but if it is known in advance, proper training, strengthening and stretching, proper form and biomechanics, and assistive devices can prevent serious overuse injuries which might cut short a lifetime of participation.^{Krivackas} Sports overuse injury prevention is called *prehabilitation* because it is preventative, as opposed to rehabilitation, which entails therapies that attempt to heal injuries after they have occurred.^{Krivackas}

Predisposition to injury can be due to configuration and alignment of the bones and skeletal system. Bone structures can only be corrected surgically and it is very rarely recommended as a preventive measure.^{Krivackas} Lack of flexibility can be addressed through stretching programs whereas excessive laxness of joints can often be improved through strengthening surrounding muscles.^{Krivackas} The other type of predisposition involves soft tissues.

For sports involving the feet, good shoes with proper cushioning and support are traditionally recommended. The barefoot styles of recent years may or may not prove to be beneficial as there are not comparative studies yet.¹³ Barefoot shoes do encourage a more natural stride and distribute the load on the foot very differently than traditional athletic shoes.¹³ If you are having foot problems, the current advice is that you may find that a totally different type of foot gear may resolve your problems, or at least you may find that certain shoes work better for one type of activity than another.¹³

Use of orthotics are often prescribed in an attempt to realign the foot and prevent misalignment of the knees and legs. The two types of orthotics, rigid vs. softer materials that accommodate to the foot differ in the way they modify foot position. Research on the effectiveness has not been conclusive, but it appears that orthotics may be helpful in cases of foot pronation and a hybrid of functional and accommodative orthotics may be best.^{Krivackas} A subjective survey of runners found that 78% felt orthotics were beneficial and they may be helpful in altering the biomechanics and loading of the lower extremities reducing the chances of overuse injuries.^{Krivackas}

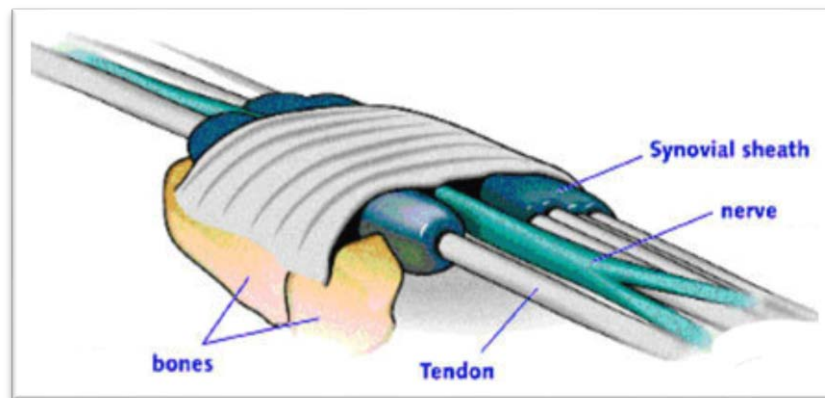
Floor, court surface, and terrain all play a factor in the stress on lower extremities during sports like running and tennis.

Equipment ergonomics

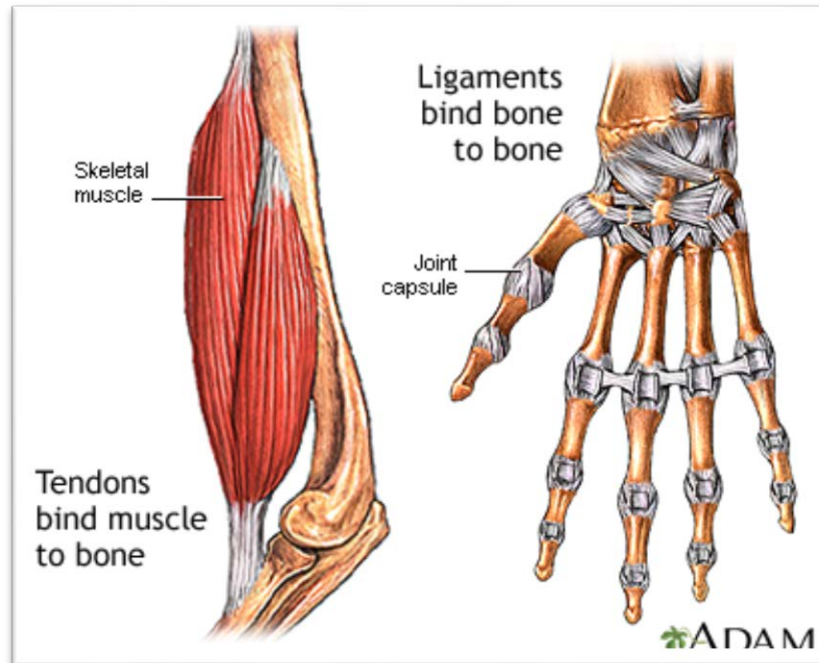
Pay attention to proper equipment size, weight, and fit with your body. For instance, a tennis racket with the wrong grip size or that is too heavy often leads to injury.¹⁴ A grip that is too small places strain on the wrist. A grip that is too big requires greater contraction of the forearm to hold the racket often leading to tennis elbow.¹⁴ A light racket with looser strings and the correct grip size will help avoid injury. The equipment you wear for safety should also fit properly.¹⁵

What are tendons, ligaments, cartilage, and bone?

Tendons are soft connective tissues made up of bundles of collagen. One end of the tendon merges with the thin membrane covering the bone (periosteum).¹⁶ The other end of the tendon merges with the membrane covering the muscle (fascia).¹⁶ There are 2 main kinds of tendons, those that transmit loads (such as the kneecap tendons and Achilles tendons at the back of the ankle) and those that primarily result in motions (tendons causing the flexing and extension of a joint).¹⁶ Where tendons pass over bone, they are encased in a fluid-filled sheath called the synovial sheath. The fluid is called synovial fluid.



Ligaments are tough bands of fibrous tissue that connect bone to bone or bone to cartilage (in contrast to tendons which connect muscle to bone).¹⁷ The main function of ligaments is to provide stability to the skeleton and to joints, preventing abnormal movements of joints.¹⁷ Although they are very strong, they can be torn, usually in a sudden traumatic event.¹⁷



Cartilage is also connective tissue composed of collagen fibers, proteoglycan, and elastin fibers.¹⁸ Cartilage is found in many parts of the body: joints between bones, at the ends of the ribs, between the vertebra, ears and nose, and bronchial tubes.¹⁸

Bone is also made mostly of collagen that is formed into a framework that is filled with calcium phosphate to form a strong, hard substance.¹⁹ Bone is constantly renewed in a process called remodeling where old bone tissue is broken down and absorbed by the body while new bone tissue is laid down and formed to replace the old. Several vitamins and hormones regulate the remodeling of bone.¹⁹ A balanced diet rich in calcium and Vitamin D along with weight-bearing exercise, and no smoking or excessive drinking all help immensely in maintaining strong bones throughout life.¹⁹ Osteoporosis develops when the bone rebuilding activity doesn't keep up with bone breakdown and it is more likely if you didn't develop maximum peak bone mass during your bone-building years before age 20.¹⁹

Tendons: injuries, repair, and healing

Injuries to tendons can be acute or chronic. Acute injury happens when some specific trauma suddenly damages a tendon. Chronic injury is something that happens gradually over time to injure tendons. It's called tendinopathy and it affects millions of people involved in sports, occupations, hobbies, and everyday living. Chronic tendinopathy results in pain and inflammation, and eventually the formation of damaging compounds within the tendon and calcified tissues in the damaged tendons.¹⁶

Regardless of the source of damage, injured tendons take a long time to heal, sometimes requiring surgery. During the healing process, scar tissue is often formed which is a disorganized matrix of dense collagen fibers, different from the organized, straight fibers in the original tendon collagen fibers.^{20, 16} The scar tissue has inferior mechanical properties from the original tendon tissue and is therefore prone to re-injury.^{20, 16} In addition, the scar tissue often

grows to adhere the tendon to the surrounding synovial sheath.²¹ Animal experiments have found that adhesions are the worst when the tendon is immobilized.²¹

There are different types of collagen that form the tendon tissues. In normal, healthy tendons, 70-80% is Type I collagen, the magic ingredient that contributes to their tensile strength.¹⁶ Other types of collagen regulate fiber diameter, lubrication, repair of damaged cells, etc.¹⁶ Other compounds in the tendon are responsible for retaining water, resisting compression, maintaining mechanical stability, enabling tendons to return to pre-stretched lengths, etc.¹⁶ Ruptured tendons contain both Type I and Type III collagen. It is now thought that the development of the disorganized matrix of fibers and Type III collagen are not caused during healing or damage to the tendon, but are likely a precursor to rupture during a degenerative process.^{Archambaut}

Research is under way to determine new ways to assist in surgically repairing tendons or encouraging healthy regrowth. The most promising appears to be a method of extracting Tendon Stem Cells (TSC) from a patient's own healthy tendon (needle biopsy), growing more identical stem cells in the laboratory, then injecting them into the damaged site.^{22, 23} The needle biopsy of healthy tissue is quite non-invasive and avoids damage to the healthy tendon, a problem with former procedures attempting to graft new tendon tissue which did usually compromise the healthy tendon. The procedure does not require surgery, is fast, and in preliminary research, it appears that the tendon can regrow in a fairly healthy manner.²³

Tendons apparently require some movement, loading, and stretching to heal properly. This varies depending on the location of the tendon. Excessive loading can result in weakening of the repair, whereas controlled loading can enhance healing.²⁴

Ligament injuries, repair, and healing

Some of the common ligament tears are Anterior Cruciate Ligament (ACL) of the knee, ankle ligaments, and shoulder ligaments.²⁵ Use of arthroscopic surgery is most commonly used to repair torn ligaments and the outcome is very good.²⁶ The most recent research is following the lead of tendon repair research in attempting to use stem cells in repairing damaged ligaments.²⁷ Specifically, stem cells from bone marrow (mesenchymal stem cells, MSC) grown in a collagen scaffold in the laboratory has been used to repair damaged ACL in rabbits.²⁷ Success using the MSC/collagen scaffold was greater than either suturing only or use of the collagen scaffold alone, but still only about 1/3 of the subjects had successful repairs, perhaps due to the fact that subjects were not immobilized during healing.²⁷ The procedure is still experimental, but it holds promise for the future.

Stress Fractures

As with other overuse injuries, stress fractures of the bone result from repeated microtrauma. Some theorize that it occurs when muscles become fatigued and are unable to provide proper shock absorption, others theorize that it is the repeated force of the muscle on the bone itself that causes the fracturing.^{Krivakas} It is likely that a combination of these factors come into play to varying degrees. Women are at higher risk than men for stress fractures. In athletes, a combination of eating disorders, amenorrhea (no periods), and osteoporosis seem to work together to increase the odds of stress fractures.^{Krivakas}

Cartilage damage

High impact and contact sports are a factor in cartilage damage and the development of osteoarthritis.²⁸ As people get older, osteoarthritis becomes more common. The cartilage wears down and the bone starts to rub on bone at the joints. Osteoarthritis is brought on by a number of factors including hereditary predisposition, contact sports, and excess body weight.²⁸ Damage to cartilage can occur as either repetitive blunt trauma or high-energy pounding of joints. Damage to cartilage may not be observable through normal imaging techniques. Special MRI techniques are required to make early detection of cartilage damage.²⁹ Cartilage does not regrow though new research is showing promise. Once you are an adult, the cartilage in joints is complete and injury to the cartilage will not be repaired by the body.³⁰

Recent research in biomimicry has led to the development of a gel that can be injected into the damaged joint where it assembles and forms a solid matrix or nanoscopic fibers. This matrix stimulates stem cells in the bone marrow and concentrates the body's growth factors into repairing and regenerating cartilage.³⁰ The matrix only needs to be present for a month to start the process of regeneration and it then biodegrades into nutrients and is replaced by the body's own cartilage.³⁰

Treating overuse injuries

The following are suggestions to help you recover from overuse injuries:²

- Cut back the intensity, duration, and frequency of your activity
- Alternate days of hard/easy workouts
- Incorporate cross-training with other activities to broaden and maintain fitness levels
- Consult with a professional trainer or coach to improve your form and techniques
- Perform proper warm-up before and cool-down after exercising
- Use ice after activity for minor aches and pains
- Use anti-inflammatory medications if needed to reduce chronic inflammation
- Get plenty of sleep.³

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