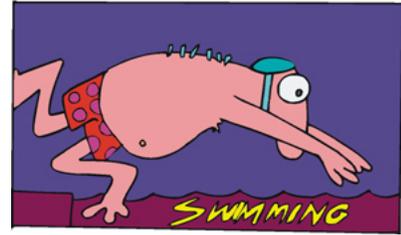


In The Swim

Prevention and treatment of swimming injuries



By Tamara Mitchell

Swimming is a wonderful, refreshing summer pastime, but it is also a great form of exercise year-round and it can be a competitive sport, too. In this article, we will discuss the sources of overuse or repetitive trauma injuries related to swimming as a sport for amateur and lap swimmers, how to prevent and how to treat swimming injuries.

Injury rates in swimming are low when compared to other sports; approximately 2.2 injuries per 1000 occasions of participation.^{1,2} Injuries are categorized as either acute (sudden, one-time injuries) or overuse (repetitive strain). Acute injuries are fairly rare in swimming since it is not a contact sport and it takes place in a forgiving body of water at relatively slow speeds. A clash of hands or fingers while swimming in lanes can cause temporary impairment of hands.¹ Other acute injuries fairly prevalent among amateur swimmers include careless behavior such as diving in shallow water, slips while running on wet pool decks or drowning while trying to swim under the influence of alcohol.¹ Acute, painful muscle strains can occur if there is not adequate warm-up or if there is overstretching.¹

Most of the injuries swimmers experience are chronic in nature and are due to repetitive microtrauma or overuse.^{1,3} The elite swimmer experiences higher injury rates than the recreational swimmer primarily because training tends to stretch the body to its limits of endurance.

Physical factors that contribute to overuse injuries include joint alignment problems, muscle imbalance, inflexibility, muscle weakness, and ligament instability.³ Nutritional concerns are also critical. During high-intensity workouts, glycogen levels fall to low levels, and if depleted, the body must break down stored fats; an inefficient method of obtaining energy during high energy demand which contributes to fatigue.³ Stroke mechanics change with fatigue, increasing the risk of injury to joints.^{3,4}

Training factors that contribute to overuse injuries include poorly planned or executed training programs, poor swim techniques, swimming too much, or, for competitive swimmers, a mismatch between a swimmer and events.³ There is increased stress to the joints if technical stroke flaws exist. Training too hard and too fast is likely to put the swimmer at risk of injury.³

Specific injuries and their treatment will be discussed later in this article, but the most common injuries are to the shoulders followed by the knees, hips, and neck.^{5, 6,7} Problems with the back occur primarily in competitive swimmers using the dolphin kick.⁵

Warm up/Cool down. Warm-up is critical to injury prevention during swimming.^{3,7} The best method for warming up is light swimming using slow, deliberate strokes.⁸ To prepare all the muscles to be used later when swimming for speed and conditioning, all strokes except the butterfly should be incorporated into the warm-up. The butterfly is too powerful a stroke to be considered warm-up intensity.³ The amount of time you need to warm up is not a rigid rule, but if you are doing a normal workout, it should be about 15-20 minutes, longer if you are planning to

compete, but you should keep the length and intensity low so it doesn't tire you out.⁹ It's intended to transition the body from an inactive state in preparation for an intense workout, so this takes longer if it's early in the morning when you haven't been moving much, if you've been sitting stationary, or if the weather or the water are cold.⁹ Start slowly and gradually with freestyle, then build up the intensity adding breaststroke or butterfly after you are partly warmed up.⁹

If a workout session includes a phase of kick-only laps, it is important to do some additional warm-ups to the upper extremities because the arms will tend to cool down during kick-only sets.^{3,4}

Cool down is just as important as warm up because it transitions your body from working hard back to a normal state.⁹ While you are working out, the contraction of the muscles assist that heart in moving the blood through the blood vessels. If you suddenly stop moving, your heart must do all the work to continue moving the blood and carrying oxygen to the body as it's in high gear from the workout.⁹ If your heart can't keep up, the blood will pool in your muscles and you will feel lightheaded and possibly faint, so you need to keep moving until you feel your heart rate return to a normal rate, your breathing is slowed down, and your blood pressure returns to normal. How quickly this happens depends on a variety of factors including how conditioned you are, how hard a workout you did, and whether you finished with some intense laps. Some easy, rhythmic freestyle and backstroke laps are good choices, avoiding breaststroke and butterfly because they are too intense.⁹ A good cool down session will avoid strain on your heart and will reduce muscle soreness.

Reduce muscle tension and increase fascial elasticity without stretching. Static and partner stretching in all sports has been shown to be of essentially *no* use in injury prevention and may actually increase the likelihood of injury in some cases.^{10,11} Increased mobility beyond a normal range of motion in the lower spine and in the shoulder increase the risk for injury. It's actually counterproductive to stretch these areas in an attempt to increase mobility further, especially because they are commonly injured in swimming.¹¹ Stretching before an activity also has been found to decrease performance, power, and strength....not good!^{10,11}

Restrictions to movement are often caused when fascia (the fibrous tissue that surrounds muscles) which becomes less elastic and more dehydrated in response to injury and overuse.¹¹ Ridding yourself of fibrous adhesions and tightness is very different from stretching muscles and connective tissues.¹² Research indicates that range of motion is increased and circulation is improved through myofascial release.¹² It's still not known how myofascial release affects performance, what parts of the body respond best, the length of time required for results, or which tools are best, but it appears that this is a promising technique.¹²

Try these techniques utilizing self-myofascial release for the lower back, chest, and shoulder.¹³

- ☞ Gluteus medius (for lower back) release video: <http://youtu.be/QPnShVc0mAY>
- ☞ Upper trapezius (top of shoulder) release video: <http://youtu.be/a3CacGo0meI>
- ☞ Thoracic spine release (chest tightness) video: http://youtu.be/_0Fi8QZOxmE
- ☞ Pectoralis major release (inside shoulder) video: <http://youtu.be/Wvpq7JldRfU>
- ☞ Lats and teres major release (shoulder blade area) video: <http://youtu.be/0gVhLFmqDhk>

Training and cross-training.

Swimming is great exercise for most people because it is easy on the joints, increases strength, and is a great option to stay fit when recovering from other injuries.¹⁴ You work all of the major muscle groups and if you swim with enough gusto, you'll get a great workout. When working

out in the pool, yardage and intensity should be increased gradually with long warm-up and cool-down periods.⁴

There are days that you may want to stay dry or don't have access to a pool, you may feel wear or soreness on a particular body part from swimming, or you may desire to do some weight-bearing exercise because swimming doesn't do much to increase bone density and to ward off osteoporosis. Swimming also does little to improve balance and agility, so alternating with other activities like yoga, running, tennis, or weights is a really good idea.⁴ Aside from the physical advantages of mixing in other activities, it will prevent boredom with your swim routine.

Both dry-land and pool-based exercises should focus on building strength and endurance of the muscles involved in swimming as well as increasing core strength, cross-training, and flexibility.^{3,5,15} Both aerobic and anaerobic training will reduce muscle fatigue and increase endurance.⁵ Any training should be gradual. Start slowly with light weights or no weights and few repetitions, and then gradually increase as you build up strength and endurance. Even though strength and conditioning can reduce injuries overall, you can damage your body by asking it to suddenly perform too much, too soon.¹⁵ Keeping a log or journal of your training will enable you to track progress, determine when it's time to increase intensity, and to keep tabs on how you feel after a workout.¹⁵ Back off if you feel pain other than regular muscle fatigue or if you experience excessive tiredness or fatigue. We only give a couple of examples here because your strengthening and conditioning routine needs to be carefully tailored to your ability level and goals.

☞ Shoulder dry-land strengthening video:

http://youtu.be/tP7fV_d7cDQ?list=PL0521BE75ACEF3274

☞ Overall strength and core conditioning for swimming: http://youtu.be/OAg_rKf940s

Technique. Interestingly, humans are the only mammals that must learn how to swim.¹⁶ All other mammals instinctively know how to swim. Regardless of which stroke is used, it is important to master technique to avoid injury and achieve efficiency in the water.¹⁶

Proper swimming technique involving stroke, kick, and breathing as well as overall form, force, and streamlining greatly improve the ability to swim without injury.^{3,5} One thing to understand is that speed in swimming is not a matter of absolute force. World class swimmers are not fast because they take a lot of strokes; they are fast because they travel further in the water with each stroke. In order to do this, you must reduce the resistance to forward progress.¹⁶

One of the most important concepts in swimming, drag force, is the mechanical factors unique to the water environment. *Form drag* is the resistance exerted on the body dependent on the position of the body in the water. Any position of the body angled from horizontal will increase form drag. *Wave drag* is the increased resistance of water caused by the wavelike movement of the water due to wind or turbulence from other swimmers in the pool. In open water, wave drag can be caused by wind, boats, and water currents.³ Wave drag is decreased in deeper pools and pools using wave-dispersing lane lines. *Frictional drag* is created between the body and the water. Body hair, swim suit materials, and swim caps all have an effect on frictional drag. Some swimmers shave their bodies to reduce this force, though it should be reserved for the championship swimming because it can induce infections of the hair follicles.³

Streamlining your stroke, reducing drag, timing of force so that it's at the portion of the stroke that utilizes it most effectively, and directing force so that your effort efficiently propels you in the direction you want to go are all important factors not just in increasing speed, but reducing the counterforces that fatigue body parts and lead to overuse injuries.¹⁷

Vary the strokes while working out or training. Using any particular stroke excessively will lead to overuse, so break up your workout doing a few laps of each stroke and rotating through them to avoid overfatigue of particular muscle groups.^{5,7}



Illustration courtesy of Reference 17.
Grant Hackett of Australia, Athens 2004 Summer Olympic Games

- 🌀 Freestyle technique video: <http://youtu.be/EFckNYtSKfc>
- 🌀 Freestyle breathing/head rotation video:
http://youtu.be/iq3bFifKe_E?list=PLU0b62Eside1_y7XCvWy3fgopmfjPpGn
- 🌀 Breaststroke technique video: <http://youtu.be/625GoD-XXv4>
- 🌀 Breaststroke stroke technique video: <http://youtu.be/bissLOYrGQ8>
- 🌀 Breaststroke kick technique video:
http://youtu.be/ovd_nlULAwg?list=PLU0b62Eside1_y7XCvWy3fgopmfjPpGn
- 🌀 Breaststroke head position video:
http://youtu.be/iq3bFifKe_E?list=PLU0b62Eside1_y7XCvWy3fgopmfjPpGn
- 🌀 Backstroke technique video: <http://youtu.be/uA5SUmIw97U>
- 🌀 Backstroke stroke technique video: <http://youtu.be/xviHn1Qg-5s>

You should utilize the assistance of a good swim coach if you have one available to help you improve your specific technique and to suggest drills, and routines that will help you improve and define technique that works for your body. Online videos such as the ones we provide in this article will enable you to see what is recommended by some of today's top trainers. Watching a video will enable you to see what excellent technique is, how to properly perform exercises, and gain insights into what you can do to improve your own skills to avoid injury, but that doesn't replace the individual guidance of a good coach.

What exactly are the qualities of a good coach and how do you find one? First, a good technique coach will not set down rules that are a cookie-cutter formula that is the same for every person.¹⁸ Everybody is built differently and what works for one swimmer may actually cause injury or result in rigid form for another swimmer.¹⁸ While the end result is to have a stroke that propels you through the water with as little resistance as possible, the method for getting there may be completely different from one person to another, so a coach may give what seems to be conflicting advice to different swimmers, but that is the art behind the sport.¹⁸

A good coach will be *knowledgeable* about physiology, teaching and training techniques, and about the sport of swimming including stroke mechanics, safety, and training methods.¹⁹ A good coach will be organized and well prepared.¹⁹ And a good coach will be sympathetic to their athletes, have empathy for emotions, and to feel the joy or frustration of each swimmer they are coaching.¹⁹ Is your coach all of these things? If not, try to find another one, but at least don't continue doing anything that seems to be causing strain or pain!

Pool temperature

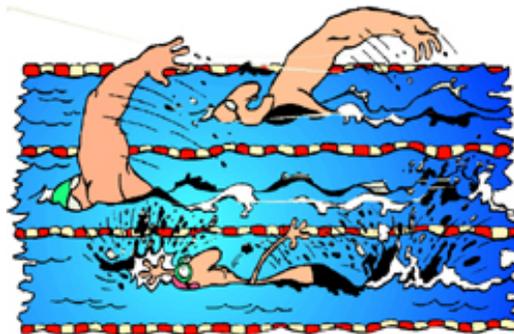
Pool temperature should be kept between 77 and 81° F for training. Cold pools can cause muscles to be more prone to strain due to decreased blood flow. Additional warm-up may be necessary in colder pools.³ Warmer pools may increase the core temperature of the swimmer and lead to fatigue and poor muscle performance.³

Overtraining, Rest, and Diet

Overtraining occurs when swim training outpaces rest and recovery.³ Rest is a really important part of any workout regimen because it allows your body to recover and mend.⁵ A well-balanced diet without rapid weight loss is important to maintain muscle strength and power.³

As few as 10 days of increased training without adequate rest may decrease performance.⁴ A sudden, unexpected drop in performance that can't be explained by illness or injury is the primary indication of overtraining. There is a multitude of physical and psychological complaints including sleep and appetite disturbances, tiredness or fatigue, aching heavy muscles, depression, irritability, and loss of motivation.^{1,3,4} A rising resting pulse rate may indicate overtraining.⁴ In general, it is a breakdown in the balance between the demands placed on the body and its ability to recover; essentially an overuse injury affecting the whole body.¹ It is important to recognize the importance of sufficient rest, good diet, appropriate level of fitness, mental status, lifestyle stresses, and the effect of recent illness.^{1,3,4}

Treatment for overtraining involves rest with very light aerobic exercise for a few days to several weeks.^{1,3,4} Overtraining can be prevented if both the coach and the athlete recognize that adequate rest is part of training, especially during the heaviest training periods and following injury.^{3,4}



Recovery from Injury

The concept of *relative rest* involves a program where the injured structure is rested, but the swimmer keeps active with alternative swimming activities and dry-land exercises that do not stress the injured structure.⁴ The repetitive nature of the swim stroke and kick makes it relatively easy to re-injure joints if the person returns to using the injured body part prematurely.⁴

For good reason, swimmers are reluctant to take time off for rehabilitation. Rest is critical to healing and rehabilitation, however studies have shown that a 4-week interruption in training

dramatically changes the metabolic characteristics of a swimmer's muscle.⁴ Although aerobic capacity and muscle strength are maintained despite reduced training for this period of time, the ability to generate power during swimming is significantly reduced and complete inactivity leads to decreased aerobic capacity.⁴ Complete rest from swimming is, however, necessary to allow injuries to heal.

Injuries to the shoulders

Swimmer's Shoulder (SS) accounts for approximately 60% of the overuse problems in swimmers.¹ Use of drag suits and hand paddles are designed to increase resistance and these may precipitate overuse problems if not used with caution.^{1,3,4} Regardless of the swimmers' specialty stroke, 75% to 90% of training is done freestyle (front crawl).⁴

Swimmer's Shoulder is an impingement injury due to overuse or instability of the shoulder joint.^{1,4,20} The normal, smooth, guiding motion of the shoulder is lost due to the entrapment of the soft tissues under the point of the shoulder.¹ This results in inflammation of the supraspinatus and/or biceps tendons of the rotator cuff muscles and the small stabilizing muscles adjacent to the shoulder joint, and/or instability of the joint itself.^{1,3,4,20} It seems to occur under one or more of the following circumstances.^{1,3,4,20}

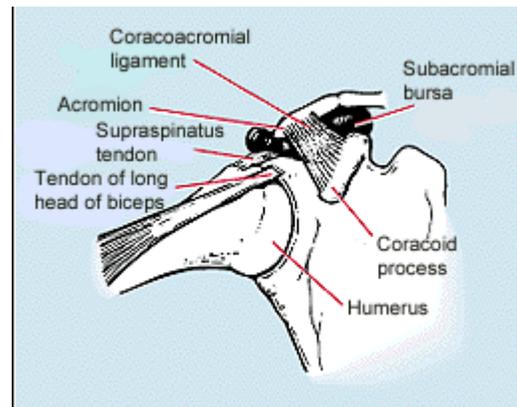


Illustration courtesy of Reference 4

- Faulty stroke mechanics
- Sudden increases in training loads or intensity
- Repetitive micro traumas related to overuse
- Training errors (such as unbalanced strength development)
- Use of training devices like hand paddles
- Stretching the shoulders²¹
- High percentage of freestyle swim practice
- Weaknesses in the upper trapezius and serratus anterior
- Weakness or tightness of the posterior cuff muscles or a hyper mobile or very lax shoulder joint

Treatment. Initially, ice should be applied to the injured area, later changing to contrasting treatments of moist heat and ice twice per day.^{1,3,20} Electronic stimulation can help manage pain, and ultrasound or NSAIDs can be used to reduce inflammation.^{1,3,4} A very high percentage of swimmers have structural abnormalities of the shoulder, but do not have any symptoms.²² If there is chronic pain, a rehabilitation specialist, such as a sports physical therapist, is mandatory for treatment. Diagnosis using x-ray or MRI can be very misleading since most swimmers have structural abnormalities that may not be related to the symptoms.²² For this reason, physicians are *not* necessarily the people you should rush to if you have shoulder symptoms.

Rehabilitation should use a length, strength, and timing (LST) program rather than traditional approaches which focused simply on strength and stretching.²² Using the LST program, which is well-rounded, to prevent injury will result in fewer injuries to begin with.²² Refer to Reference 22 for more information about LST rehabilitation and training.

Thoracic Outlet Syndrome (TOS) can occur in swimmers because swimming involves so much repetitive overhead motion.³ TOS is the entrapment of the nerves and/or blood vessels in the area of the neck and shoulder region. A complete discussion of this disorder is described in our article on "[Repetitive Strain Injuries: Nerve and Circulation Problems and Related Disorders](#)".²³ Differentiating between SS and TOS in swimmers is sometimes difficult and often overlooked. Complaints may range from pain, numbness, and tingling, tightness and pain around the shoulder, neck, and clavicle at the point where the hand enters the water, pain in the lower face and ear with possible headaches, and pain into the shoulder, thumb, index, and middle fingers.³

Treatment. Treatment begins by reducing inflammation. Muscle imbalances and poor posture can contribute to nerve and blood vessel compression.³ Slouching is a typical posture of swimmers; it contributes to a downward pressure of the clavicle on the first rib.³ The large chest and shoulder muscles of swimmers present their own complications in postural training for relief of TOS.³ Myofascial release and stretching of the muscles of the upper quarter of the body should begin immediately.³ Please refer to the links earlier in this article in the section titled "Reduce muscle tension", for some excellent online videos of self-myofascial release that will reduce symptoms for all areas of shoulder and chest.

Injuries to the elbows

Lateral epicondylitis is a common injury in swimmers.³ This disorder is discussed in detail in our article: "[Repetitive Strain Injuries: Muscle and Tendon Disorders](#)".²⁴ Use of the high elbow position during the pull phase of the stroke in freestyle may predispose the swimmer to increased strain on the medial elbow.^{3,4} A swimmer may drop the elbow during this phase to compensate for painful weakness at the elbow, decreasing the efficiency of the stroke and increasing the stresses on the shoulder and wrist extensor muscles and tendons.^{3,4} This stress can also increase the risk of elbow injury.⁴

Other overuse injuries of the elbow or triceps may occur with full extension of the elbow during backstroke.⁴ Analysis and alteration of stroke technique are important in prevention and management of elbow injuries.⁴

Treatment. Treatment of elbow injuries include use of ice and NSAIDs to manage inflammation.³ Stroke mechanics must be evaluated and modified. The swimmer should avoid all strokes that cause pain to the elbow.³

With lateral epicondylitis, if there is a history of pain with use and decreased pain with rest, this indicates that there is irregular healing of the tissue following multiple repeated microtears of the tendon.³ This type of injury lends itself to treatment with deep friction massage, which realigns the fibers of the tendons so that they decrease the irritation at the site of the injury.³ Seek out the assistance of a sports massage therapist.

With triceps strains and synovitis, elbow braces have been used to limit the amount of elbow extension used during the backstroke. While these braces are useful in preventing further stress in training during the acute inflammatory stage of the injury, they do nothing to correct improper stroke mechanics, the source of the problem.³ Braces are not allowed during swimming competitions.³

Once inflammation has been resolved and the integrity of the tendon reestablished, the swimmer can return to swimming with improved mechanics, gradually building speed and distance.³

Injuries to the knees

Almost all knee injuries in swimmers are related to the use of the whip kick in the breaststroke.⁴ This problem accounts for about 25% of chronic injuries in swimmers.¹ "Breaststroker's knee" is a chronic repetitive stress injury of the ligament that stabilizes the inside of the knee (medial collateral ligament).^{1,3,4} Breaststroker's knee occurs more as a result from stress than from technical errors, though aligning the knee with the hip and allowing the knees to separate only to hip width will minimize stress and maximize kick efficiency.^{3,4} To avoid breaststroker's knee, minimize breaststroke distance by cross-training with other strokes, always warm-up, and increase training distance gradually.^{1,4}

Treatment. Treatment begins by reducing inflammation and swelling, if it is present.³ Avoid swimming the breaststroke until the acute swelling is under control, cross-train with other strokes, warm-up, and increase training distance gradually as long it is pain-free.³

Injuries to the hips

Hip pain is not a big problem for swimmers. Swimmers who swim a lot of breaststroke may experience hip pain from inflammation of the hip tendons.²⁵ If the legs are rotated out at the hip and the knees are brought up too far to the side, it can put a lot of stress on the hip joint.^{26, 27} Keeping the knees narrow and in line with the hips, bringing the feet up to the butt, keeping the body in a straight line, and kicking straight back with the feet wider apart than the knees are all demonstrated with excellent coaching in the video, Reference 26. Warm-up is especially important with the breaststroke kick and alternating with other strokes will prevent straining the hips or the knees.²⁷

Treatment: Avoid swimming the breaststroke until pain is gone. Study proper technique and work with a good coach to correct the form of your kick.

Injuries to the back

Swimming can actually be a very good activity for people who are recovering from back pain, but good form is critical.²⁸ Lower back pain is not uncommon in elite swimmers accounting for about 10% of all orthopedic problems.¹ Low-back injuries in swimmers are usually caused by repetitive stress during turns and the strain of poor head and body position in the water.³ The Butterfly typically results in repeated hyperextension of the lower back. Kicking drills where the upper body remains relatively stationary due to the use of an arm float exacerbate symptoms of lower back pain.¹ Most problems are minor and are likely to be muscle or mild ligament sprains.¹

Treatment. Treatment involves relative rest (resting the body parts that hurt) by avoiding diving and flip turns and any strokes that cause back pain followed by a strengthening and exercise program with a physical therapist.^{1,3,28} Chiropractic care can often help relieve symptoms.²⁸

Swimmers often have an imbalance in strength of the trunk muscles due to an emphasis on face-down swimming which strengthens only the trunk extensors. Flexibility of the hamstrings and back extensors is important to ensure normal movement of the pelvis.³ If pain persists for 3 weeks, the problem should be investigated further to rule out stress fracture.^{1,28} Continuing activity will prolong symptoms and may lead to vertebral slippage, a much more serious problem if stress fracture exists.¹

Injuries to the neck

The neck is a weak structure in the human body and technique is especially important to avoid strain and repetitive stress to the neck.²⁹

- Freestyle. The head should be aligned with the spine with the eyes looking towards the bottom of the pool.²⁹ When you breathe in, roll the whole body toward the breathing side and do not over-rotate the head.^{28,29} Try to keep one goggle in the water. The head will create a bow wave and a pocket of air that keeps you from taking in water even though your head is turned very little.²⁹ Alternate breathing to both sides to avoid muscle and spinal imbalances.^{3,29} Muscle spasms and difficulty moving the neck may result from single-sided breathing.³
- Backstroke. It seems that backstroke would have little cause for neck strain as the head is always aligned with the spine and the swimmer looks straight up at the ceiling. In fact, the head is buoyed up by the water which causes the muscles in the back of the neck to be pressed up and muscles in the front of the neck can become fatigued.^{28,29} Gradually build up backstroke distance to allow the neck muscles to gain strength.
- Breaststroke and Butterfly. Glide the head into the water after the inhale rather than swimming breaststroke with the head out of the water continuously.²⁹ Some people want to avoid getting their face wet, but this causes the neck to be under constant tension holding the head up the entire time. With both breaststroke and butterfly stroke, do not tilt the head back to look at the end of the pool when coming up for the inhale. Look down and slightly forward instead.^{28,29} Some swimmers look to the side when inhaling with the butterfly stroke, but this can cause unnecessary tension, twisting, and rotation.²⁹

Treatment. Treatment consists of resting the area, decreasing muscle guarding or spasm, and reestablishing normal movement of the vertebrae through chiropractic manipulation.³ Relaxing tight muscles, correcting techniques contributing to the problem, and postural reeducation and strengthening is important to prevent reoccurrence.³

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