Finding Out About Stretching

In martial arts, good flexibility is normally considered a desirable trait. Being flexible and limber generally means a martial artist can kick higher, be able to reach farther, and be quicker than someone who is stiff and inflexible. However, although many martial artists stretch, most are not aware of exactly what they are doing or what happens to the body during the process. Many end up stretching incorrectly or push their stretches past their physical limits or the point of prudence. Some aren't even aware that certain stretches can possibly injure them, since the stretches are taught by their instructor and included as part of their training: Their reasoning is that it must be safe if it is taught to them. However, the instructors themselves may not be aware of the dangers inherent within certain stretches and stretching techniques. Thus, this paper's purpose is to give a general overview of what stretching is and what the body's limitations are. It provides an explanation of the benefits and dangers of stretching and of some stretching methods. What it does not do is instruct a person on exactly how to stretch or provide a stretching regimen, and proper medical advice should be obtained from a physician or health care professional before beginning any new stretching routine or when injured.

Stretching the Joints and their Components

The simplest definition of flexibility is the mobility or range of movement in a joint.[1] A joint is basically the junction of two or more bones which are connected to each other by ligaments and which are manipulated by muscles and tendons. Tendons are the connective tissues which attach muscles to the bone, and the contraction and relaxation of the muscles move the bones in the joint. The ability of a joint to move depends on its structural limitations and the strength and length of

the muscles and connective tissues which are part of it — joints can be immovable, slightly movable, or freely movable.[2]

Only certain components of a joint should be stretched to improve flexibility. Stretching generally should not include the ligaments because they are mostly composed of collagenous tissue, and the collagenous fibers, although strong and capable of resisting high tensile stress, are extremely inelastic.[3] A ligament stretched past its maximum length will not return to its original resting length and will become permanently extended. When this happens, the joint becomes unstable and loose, which increases the chance of becoming injured.[4,5,6] This doesn't mean that ligaments shouldn't be stretched at all: Ligaments are stretched all the time in normal movement and very minor tension on ligaments is healthy.[7] However, they should not be stretched to improve flexibility.

The tendons of a joint are slightly more elastic than ligaments; this is because tendons are composed not only of collagenous tissue but also elastic tissue. Unlike collagenous fibers, elastic fibers yield easily to stretching and have the ability to return to their former length.[8] The combination of these tissue types allows the tendons to be stretched approximately 4% of their normal resting length, with the collagenous tissue resisting the tensile force and providing stability, and the elastic tissue providing elasticity.[9,10] However, if tendons are stretched past their maximal extension, they, like ligaments, will become permanently extended and will also become strained.[11,12] If enough stress is placed upon a tendon or ligament, it will tear, resulting in an injury which may require long recuperation, therapy, and possibly surgery.

Effectively, only the muscles of a joint can be seriously stretched. A muscle is composed of many sheathed muscle bundles, which themselves are composed of many sheathed muscle fibers. The fibers are made of smaller sheathed units called

myofibrils, which, in turn are comprised of long thin strands of sarcomeres (Figure 1).[13] The sarcomeres are the functional units of a muscle and can be stretched to over 50% of their resting length while still being able to return to its original length.[14] Thus, a muscle can be stretched approximately 50% without real damage;[15] this, of course, varies from person to person. However, if a muscle is stretched too far, the muscle will tear and, at the extreme, rupture.

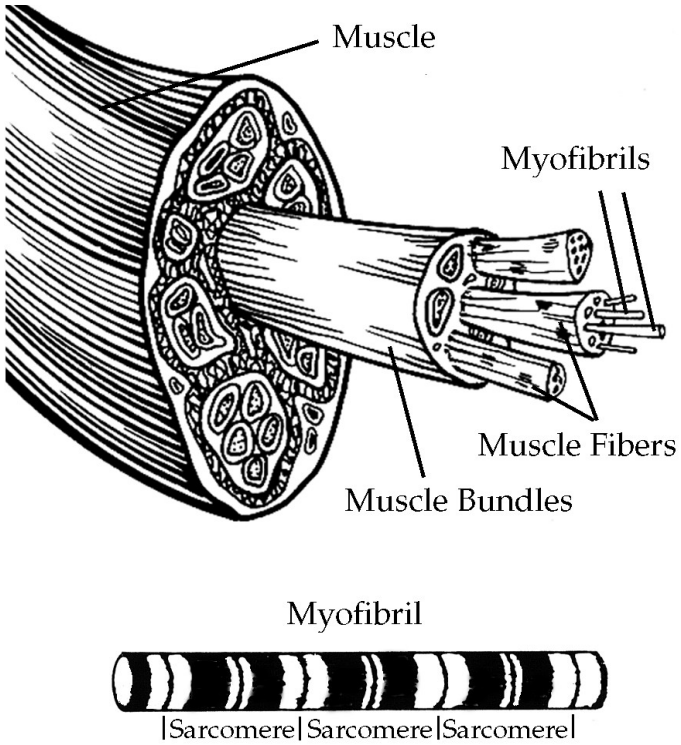

Figure 1. Muscle structure

When a person stretches, the muscle fibers are pulled to their full length first. Then the collagenous fibers in the connective tissue stretches out, aligning in the direction of the stretch in order to resist it. Some of the fibers within the muscles and connective tissues lengthen from

the stretching; others do not. By stretching regularly, a person eventually lengthens more and more fibers, thus increasing the

overall stretch.[16] However, this does not happen if a person stretches incorrectly. Thus, it is important to feel the stretching of the muscles and connective tissues occurring in order to produce results. For instance, when a person sits on the floor with legs straight out and attempts to touch his or her toes, he or she should not "cheat" by leaning the head and shoulders forward and bending the upper back (Figure 2a). The person may be able to reach the toes in this fashion but probably feels little or no stretching sensation in the hamstrings and lower back. In this particular stretch, the person should be bending from the waist while keeping the back straight and head up (Figure 2b). If no stretching sensation is felt, the person should lean forward more until it is felt within the appropriate muscles; this way his or her stretch will actually improve.

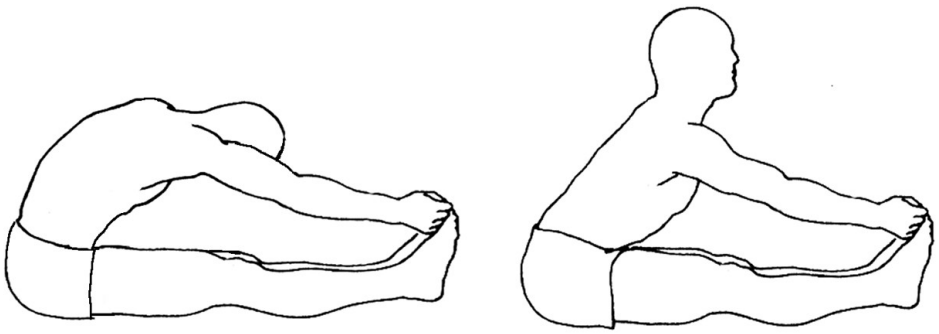

Figure 2. Incorrect stretch (a) and correct stretch (b)

Factors Limiting Stretching

Although most people want to be extremely flexible, it is often simply impossible for people to stretch well in certain directions and trying to do so will end in injury. There are many factors affecting a person's flexibility which are beyond the control of the person: The most obvious of these is the physical structure of the person. Some people simply have looser joints, a larger range of motion, or

longer muscles;[17] others may have hypermobility, or "double-jointedness". The most apparent difference in the physical structure of the body occurs because of the gender of the practitioner: Women, as a general rule, are more flexible than men, especially in the hip region. The female hip is generally broader and shallower than a male's hip, and this allows for a larger range of motion in the pelvis (Figure 3).[18]

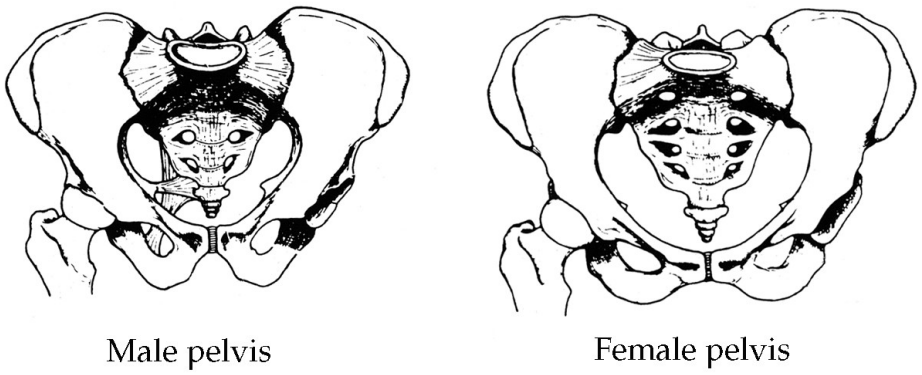

Figure 3. Male and female pelvis

And during pregnancy, a woman's pelvic joints and ligaments become relaxed and stretch, which changes the diameter of the pelvis. After childbirth, the pelvis may return to its original shape, but sometimes it may lock into the position adopted during pregnancy, affecting the woman's flexibility.[19]

A person's age is also a factor in overall flexibility. Children are normally much more flexible than adults,[20] and it is rare to find young children who are not capable of touching their toes. However, as they grow older, bones grow longer and faster than the muscles and connective tissues grow, and this ends up tightening the joints they are connected to.[21] And, as a person approaches the later years in life, several changes occur in the body. Muscle tissue begins atrophying and is replaced with collagenous tissue, which is inelastic.[22] Moreover, the collagenous and elastic fibers in connective tissues begin bonding together and crystallizing.

This causes

them to grow not only stronger but also tighter, so they lose some flexibility and become less adaptable to changes.[23,24]

Stress and tension are obvious factors which can affect a person's flexibility. When someone suffers from extreme stress or chronic tension, some muscles in the body are constantly tensed and contracted. This contraction wastes energy, raises the blood pressure, and results in less supple and shorter muscles.[25] This is diametrically opposed to stretching, which is an attempt to pull the muscle to its maximum length. Thus, the more tense a person is, the more contracted the muscles will be, resulting in less flexibility and difficulty stretching.[26]

The temperature of the body can affect flexibility as well. In most training regimens, people are instructed to do warm-up exercises before stretching to raise the body temperature. The main reason for this is that when the body is cold, the muscles and connective tissues are tight and stiff. However, when the muscles and connective tissue of a joint are warmed up, their viscosity decreases which results in decreased resistance and increased flexibility.[27] For instance, by taking a five minute hot shower before stretching, it is possible to increase flexibility by 5% or more.[28] The process of warming the body also may help reduce stress and muscle tension and lubricate the joints, which helps increase flexibility and mobility.

Underuse and overuse of muscles, along with injuries, will also affect the flexibility of a person. In underuse, the muscles atrophy, the joints stiffen from disuse, and the connective tissues shrinken and tighten.[29,30] When a muscle is overused, the connective fibers essentially fail and tear, causing inflammation.[31] This is similar to muscle and tendon strains, which result in torn muscle and connective fibers. The body heals these injuries by laying strands of randomly arranged collagen at the injury site: These strands of tissue are called scar tissue, and they have little or no strength.[32] Thus, the muscles and connective tissues become

weaker and less able to resist tensile stress from the body. This effectively reduces the overall flexibility of the tissue.

The Stretch Reflex and Different Types of Stretching

Every form of stretching is affected by the body's response to the stretching of the muscle, which is called the myotatic, or stretch, reflex. There are two components of the stretch reflex, one dynamic and one static. The dynamic component only senses and resists fast changes to a muscle's length; slow changes will not trigger it. In response to this change, the body will contract the muscle being stretched for a brief moment — the quicker the change, the harder the contraction. The static component occurs whenever a muscle is stretched; it provides continual muscle contraction to resist the stretch.[33] These two components of the stretch reflex are designed to protect the body from injury and are triggered by any stretching.

There are several different types of stretching with many different variations. The four most common types are ballistic stretching, passive or static stretching, active or static-active stretching, and PNF (proprioceptive neuromuscular facilitation). These methods all have advantages and disadvantages, and a person should be aware of them before actually using a specific one.

Ballistic stretching uses the motion and momentum of the body while bouncing or jumping to stretch the body past its normal range of motion. There is a large amount of controversy around the use of this method in stretching. Many people argue that ballistic stretching is uncontrolled and stretches muscles and connective tissue too far. They believe this forceful extension produces a large amount of tension in all muscles and connective tissue, especially when combined with the triggering of a strong, dynamic stretch reflex. Thus, it is more prone to injury and can lead to strains, tears, and ruptures of the muscles, tendons and

ligaments.[34,35,36] However, most people agree that it is effective in developing a person's stretching ability. This stretch will also help develop dynamic flexibility: Since most activities are dynamic in nature, this helps to promote the stretching most used during the activity.[37]

Another type of stretching is static stretching, which basically involves stretching the body into a position and having it held there by some outside force (another person or the floor and surroundings) for a certain length of time. Most people perform this type of stretch, as it is considered very controlled, easy to perform almost anywhere, and effective.[38] However, static stretching is what its name implies — static. Many consider it boring, since there is no real physical activity being performed. Also, since most activities are dynamic in nature, static stretching is not the best technique to stretch the muscles used by an activity or in a manner which will aid in the activity.[39]

Active stretching is similar to static stretching, except that instead of using some outside agent to hold the stretch, the person's own muscles are used. An example of this type of stretch is stretching the hamstring by lifting and holding the leg up in the air using only the quadriceps of the leg. Active stretching takes advantage of the way muscles work in the body: When a muscle contracts (referred to as the agonist), its opposite muscle generally relaxes (referred to as the antagonist).[40] This is called reciprocal inhibition and is exhibited in many opposing groups of muscles, though not all. It is extremely effective in the ones that do because the muscle being stretched is relaxed. It has the added benefit of increasing muscle strength of the opposing, and possibly weaker, muscle.[41] However, this type of stretching may trigger the stretch reflex and be ineffective on people who are injured or have certain dysfunctions.[42]

PNF is not a type of stretching but more a stretching technique. It combines several different methods of stretching and normally uses a partner to facilitate the stretches. The most common technique is referred to as the "hold-relax" or "contract-relax" method. In this method, the muscle is first extended to its full length and stretched passively by the partner. The stretcher then slowly contracts the muscle as hard as possible and holds it for approximately seven to fifteen seconds. While this happens, the partner continues to support the area being stretched so that there is no movement or extension. The muscle is then relaxed for several seconds, after which the partner passively stretches the muscle out farther than it was before.[43]

Another common PNF technique is the "hold-relax-contract" or "contract-relax-antagonist-contract" method. This is similar to the "hold-relax" method, except that after the several second rest, the person contracts the opposing muscle while being supported and assisted by the partner. This, like in active stretching, uses reciprocal inhibition to stretch the muscle, since the muscle being stretched is the antagonist and is relaxed.[44]

Of all the forms of stretching, PNF probably has the largest gains in flexibility. It promotes greater strength and greater balance of strength in opposing muscles groups.[45] Unfortunately, performing a full set of stretches takes a long time, and it requires a good, knowledgeable partner to assist in them. What is more significant is that it produces an extreme amount of tension on the tissues. This can easily cause torn muscles and connective tissues if not carefully monitored.[46,47] It can also possibly cause cardiovascular problems in some people.[48]

Dangers Related to Stretching

As with most activities, there are dangers associated with stretching, regardless of the stretching method. Each method works against the body's stretch reflex, and by trying to stretch too far or too fast, like in ballistic stretching, a person risks injuring himself or herself minorly (microscopic tear in connective tissue and muscle fibers resulting in soreness), or majorly (a complete tear of connective tissue or rupture of the muscle).

However, even static stretches, which are slower and much more controlled compared to ballistic stretching, can result in injury to a person, especially if they are done improperly or done on weak or previously injured tissue. There are several static stretches that, in general, are dangerous to various joints of the body and should be performed with extreme caution, if done at all. Among these, most agree that the hurdler's stretch, the inverted hurdler's stretch (either single- or double-leg), the deep knee bend, the standing toe touch, the bridge, and the plough are dangerous stretches.[49,50,51]

The hurdler's stretch is performed by sitting on the ground with one leg straight in front and the other with the knee bent and the leg rotated at the hip with the heel of the foot against the buttock. The person then stretches forward towards the straight leg (Figure 4a). Although the hurdler's stretch stretches the hamstring and the lower back muscles, it places undue stress upon the knee joint, especially if the foot flares out to the side. This can overstretch the medial collateral ligaments of the knee, twist and side-slip the kneecap, and crush the meniscus (cartilage) of the bent knee (Figure 4b).[52,53] This stretch does not even need to be performed since the modified hurdler's stretch (or lateral straddle stretch) is an alternative position which stretches the same muscles (Figure 5).[54]

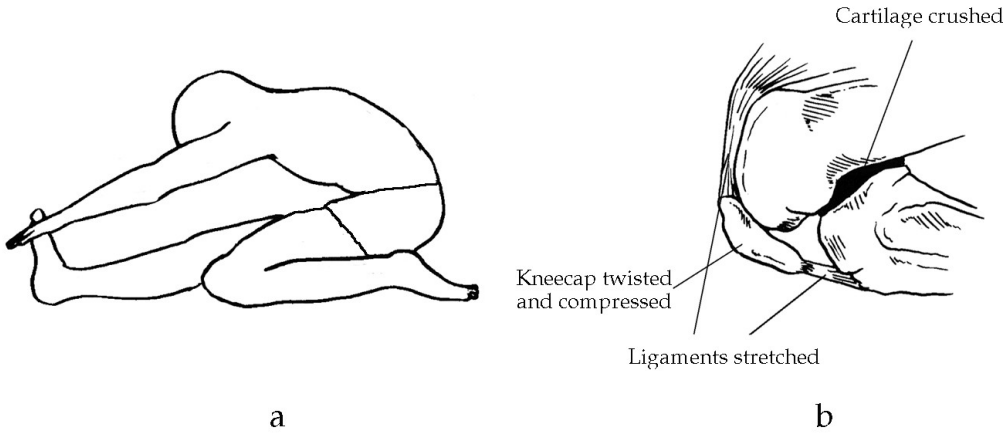

Figure 4. Hurdler's stretch (a) with corresponding damage to knee (b)

The inverted hurdler's stretch (single- or double-leg) is performed by having one leg (with the other leg straight) or both legs fully bent at the knees, with the knees pointing forward and the legs rotated at the hip so that the heels are touching the buttocks. The person then bends backward, resulting in a stretch of the

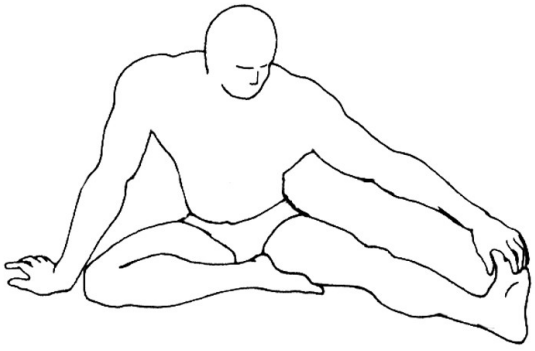

Figure 5. Modified hurdler's stretch

quadriceps of the leg (Figure 6a). The danger of this stretch is that it damages the knee in the same way as the hurdler's stretch (Figure 4b), with the added possibility of the lower back being compressed and jammed.[55] As an alternative, one can stretch by standing upright on one

leg, slightly flexed, with the other leg bent behind

and grasped by the same-side hand. The hamstring can be slowly and carefully stretched while using the other hand to maintain balance (Figure 6b).

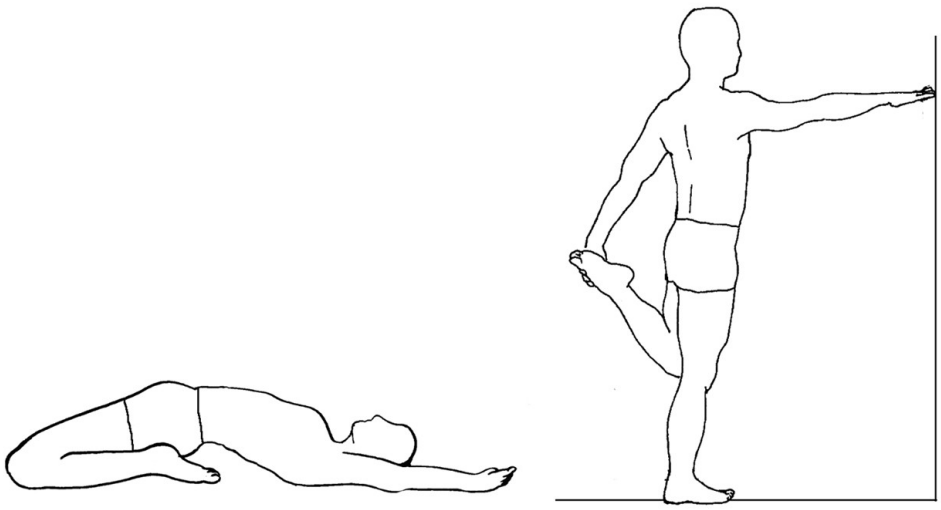

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Figure 6. Inverted hurdler's stretch (a) and alternate stretch (b)

The deep knee bend is simply an exercise in which the knee is bent farther than 90°, as in a lunge or squat (Figure 7a). When performing this exercise, the kneecap becomes compressed and the cartilage is crushed. The knee bend also strains both the knee capsule and the ligaments (Figure 7b).[56,57,58] By performing extremely deep knee bends or performing them quickly, it is very easy to tear the ligaments within the knee. To minimize the danger of this exercise, it is better to squat or lunge slowly while supporting the upper body so that the full body weight is not put onto the knees. Also, the squat or lunge should only go, at most, to approximately the 90° angle.[59]

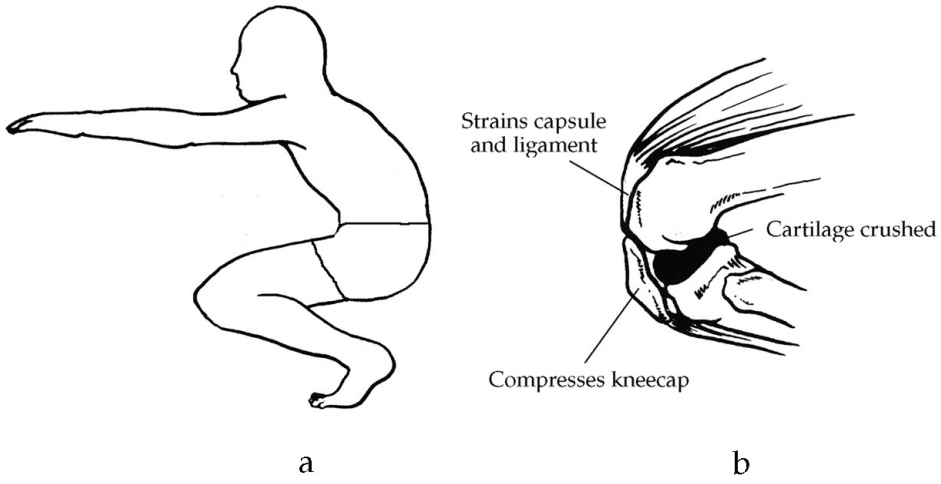


Figure 7. Deep knee bend (a) and corresponding damage to knee (b)

The standing toe touch is one of the most common stretching exercises. It is done by keeping the legs straight and simply bending over at the waist while trying to touch the toes or floor with the hands (Figure 8). However, in doing so, it is possible to stress the muscles and ligaments of the lumbar region (lower five moving vertebrae) of the spine and compress the sciatic nerve which runs from the spine in the lower back, behind the hip joint, and down each leg.[60,61] Also, depending on the spacing between the feet, it may force the knees to hyperextend,

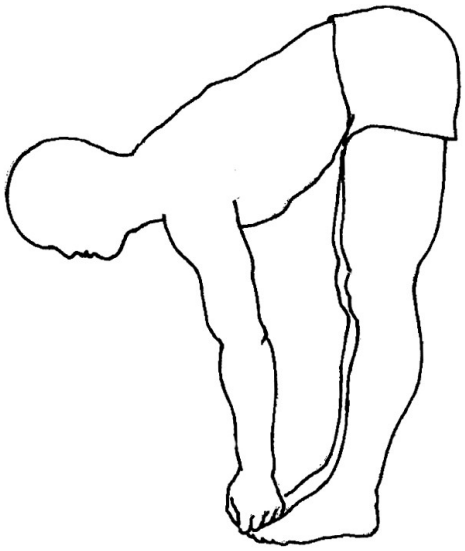
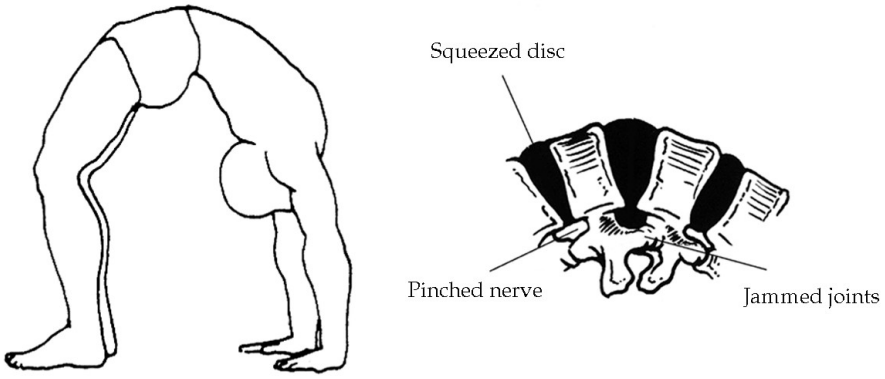


Figure 8. Standing toe touch

resulting in permanent deformity.[62] A person can lower the danger of this stretch by bending the knees slightly: This will reduce the stress to the lower back and knees. Moreover, support can be achieved by placing the hands on some object such as a chair or stool, especially if it is difficult to touch the floor.[63] The lower back should also be kept straight in order to prevent added stress upon the lower back.

The bridge is simply the arching of the back such that the soles of the feet and palms of the hand are touching the floor (Figure 9a). This increases the flexibility of the vertebrae and shoulders, but is extremely dangerous for people with bad backs,
as it squeezes the discs between the vertebrae, pinches the nerves within the spine, and can possibly jam the joints (Figure 9b).[64] To decrease the chance of injury, a minor arching of the back should be done instead, and the abdominal muscles should be strengthened for more control during arching.

One of the most potentially dangerous stretches is the plough. This stretch is performed by lying on the back and then pulling the legs up and over the head; the person then tries to touch the floor behind the head with the feet while supporting



a b

Figure 9. Bridge (a) and corresponding damage to spine (b)

the back with the hands (Figure 10). A basic problem with this position is that it stretches those muscles and ligaments which promote bad posture (a forward head and humped back).[65] Also, the curvature of the back can pinch the sciatic nerve, and it is possible to injure the vertebrae in the spine, since by adopting this position a person compresses the discs and extends and possibly tears the ligaments in the spine.[66] The danger is especially heightened if balance is lost during this stretch. This stretch should be avoided by anybody with neck or back problems, and other stretches should be performed instead.

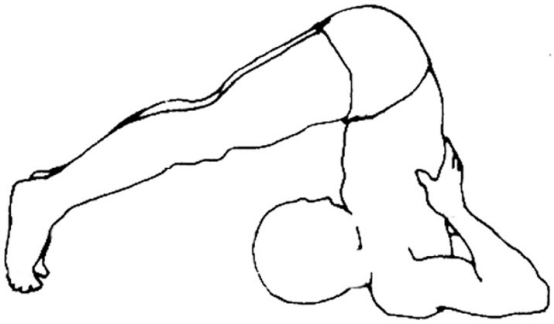


Figure 10. Plough

Although these stretches are potentially dangerous, this does not mean that they absolutely should not be done. Depending on the activity and the capabilities of the person, it can still be performed, although extreme caution should be exercised. However, if a person has any injuries or weak body conditions, they should be aware of the danger of the stretch before performing it. For that matter, caution should be utilized with any stretch, even simple, uncomplicated ones, especially when an injury or medical condition is present. Stretches should be executed slowly and should definitely not be taken to the point of pain or beyond, as pain is an indication that something is wrong.

One other thing should be considered when stretching: whether or not the body is becoming too flexible. Although people want to be as flexible as possible, doing so may actually be detrimental, especially if the muscles being stretched are not strengthened at the same time. Extremely flexible joints with no muscle strength are loose and unstable and can possibly lead to dislocations and other injuries.[67] In order to provide more support, the muscles supporting the joint must be strengthened while being stretched.

Benefits of Stretching

The main benefit of stretching is that muscles which are stretched are looser than muscles which are tight. During an activity, stressful pulling or contraction of a tight muscle is much more likely to result in the tearing of that muscle, while a loose muscle will extend more and permit greater movement. This will allow the body to be better able to withstand different stresses placed upon it by different activities. Also, stretching has the capability of relaxing the body and is useful for those with chronic tension. Someone who has chronic tension has some of their muscles constantly partially contracted. By stretching, the muscle is forced to relax and thus the whole body relaxes.[68,69]

Stretching is also useful as treatment for pain in the body. For instance, it has been found that when a person has a muscle cramp, which occurs when an already shortened muscle suddenly contracts involuntarily, the immediate application of a passive stretch can cause it to relax.[70,71] Stretching can also be used to relieve muscles which are spasming,[72] as well as many forms of back pain.

Often, back pain is the result of tight muscles. Tight hamstring muscles can pull on the pelvis, restricting rotation at the hips. This results in much of the load of bending at the waist being put on the lower back, causing excessive stretch, possible overuse, and pain.[73] Tight inner thigh muscles (hip adductors) may also cause pain by causing an inflammation of the pubic bones, pulling the thigh bones inward affecting the knees, and tilting the pelvis.[74] By stretching the hamstrings and hip adductors, it is possible to reduce and even prevent strain and pain to the knees, lower back, and pubic bones.

Some forms of anterior knee pain can be relieved by stretching as well. Often, anterior knee pain occurs as a result of the kneecap not moving smoothly over the femur (thigh bone). Stretching the hamstring and the Achilles tendon can help

decrease the pressure of the knee bone on the joint, and if combined with some strength training, may prevent pain from happening again.[75]

Stretching, along with muscle strengthening, is also often prescribed as part of therapy to help recover from injuries. In general, when a person suffers from an injury such as a muscle strain, the tissue becomes scarred and heals at a shortened length, thereby decreasing flexibility. By gently stretching the muscles while recovering, it is possible to decrease the loss of flexibility and help realign this scarred tissue so that it becomes productive again.[76] However, no stretching should be performed if it results in pain; in such cases, it is better to stretch the surrounding muscles which aren't damaged.[77]

Final Thoughts

A person should choose a method of stretching suitable to himself or herself and be aware of the dangers inherent within that method. Unfortunately, stretching normally produces slow gains in flexibility, which can be quite frustrating. However, people who do not achieve the overall stretch they desire should not view this as a personal failure – in many cases, people's physical structure prevents them from stretching well in certain directions while helping in others. Regardless of the stretching method a person uses, stretching should not be compared to others as it is not a contest. Stretching should be done according to what the individual feels comfortable with and capable of. Comfortable does not imply pain — the "no pain, no gain" axiom should not be applied, as it usually indicates the tearing and overstretching of muscles and connective tissues. Doing this actually ends up decreasing flexibility not to mention requiring varied periods of recuperation. Thus, caution and good sense should always be exercised every time a person stretches. In

this fashion, good flexibility will eventually be achieved, within the limits imposed by the body.

Notes

[1] **Staying Flexible** 1987, 7.
[2] Alter 1996, 11.
[3] Ibid., 39.
[4] Benjamin 1979, 136.
[5] Alter 1996, 51.
[6] **Staying Flexible** 1987, 14.
[7] Jerome 1987, 45.
[8] Alter 1996, 48.
[9] Jerome 1987, 83.
[10] Alter 1996, 50.
[11] Ibid., 50.
[12] Benjamin 1979, 136.
[13] Alter 1996, 17.
[14] Ibid., 31.
[15] Jerome 1987, 83.
[16] Appleton 1996, Section 1.6.
[17] Alter 1996, 107.
[18] Ibid., 142.
[19] Ibid., 144-145.
[20] **Staying Flexible** 1987, 9.
[21] Eller 1993, 70.
[22] Alter 1996, 34.
[23] Ibid., 46.
[24] Jerome 1987, 120.
[25] Benjamin 1979, 114.
[26] Ibid., 138.
[27] Alter 1996, 150.
[28] **Staying Flexible** 1987, 8.
[29] Jerome 1987, 2.
[30] Henry 1994, 84.
[31] Jerome 1987, 71-72
[32] Ibid., 73-74.
[33] Alter 1996, 95-96.
[34] **Staying Flexible** 1987, 22.

[35] Alter 1990, 9.
[36] Appleton 1996, Section 3.1.
[37] Alter 1990, 9.
[38] Alter 1996, 175.
[39] Ibid., 175-176.
[40] Appleton 1996, Section 3.3.
[41] Ibid., Section 3.3.
[42] Alter 1990, 10.

[43] Appleton 1996, Section 3.7.
[44] Ibid, Section 3.7.
[45] Alter 1996, 181.
[46] Ibid., 181.
[47] Appleton 1996, Section 3.7.
[48] Alter 1996, 181.
[49] Ibid., 211.
[50] Appleton 1996, Section 4.5.
[51] Timmermans, et. al., 1987, 29-30.
[52] Ibid., 212.
[53] Timmermans, et. al., 1987, 29.
[54] Ibid., 29.
[55] Alter 1996, 213.
[56] Ibid., 214.
[57] Timmermans, et. al., 1987, 30.
[58] *U.S. Taekwondo Journal* 1996, 8.
[59] Alter 1996, 214-215.
[60] Timmermans, et. al., 1987, 30.
[61] *U.S. Taekwondo Journal* 1996, 8.
[62] Alter 1996, 215.
[63] Anderson 1980, 52-54.
[64] Alter 1996, 221.
[65] Ibid., 226.
[66] Ibid., 226.
[67] **Staying Flexible** 1987, 14.
[68] Ibid., 1987, 12.
[69] Weaver 1982, 11-12.
[70] **Staying Flexible** 1987, 17.
[71] Alter 1986, 209-210.
[72] Pinckney 1988, 19-21.
[73] Schatz 1994, 115.
[74] Schatz 1994, 101.
[75] Rizzo 1991, 147.
[76] Jerome 1987, 17.
[77] Mann 1996, Internet site.

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