

Wound Healing and Tissue Repair

WHAT ARE LIGAMENTS?

Ligaments are cable like structures which hold your bones together and allow you to walk and move without falling apart. Ligaments are flexible, but they do not stretch very far. Injuries, such as when you sprain an ankle, twist a knee, take a bad fall, suffer a whiplash, or lift an object which is too heavy, can tear or fray these cable like structures. These injuries set up a healing process called inflammation to repair the injured ligament. You know this process is happening when you feel the pain, heat, note swelling, and cannot move the injured joint. If the healing process is completely successful then the ligaments will be returned to their normal strength and length and you can return to your normal activities. If this healing process does not completely work, the ligaments may heal stretched. This "stretched out" ligament will lead to a situation which can cause pain and discomfort with movement. (Cailliet)

When a ligament is "strained" or injured, some of the strands or threads which make up the cable become over stretched and broken. The torn or strained ligament are really millions of tears of these strands which

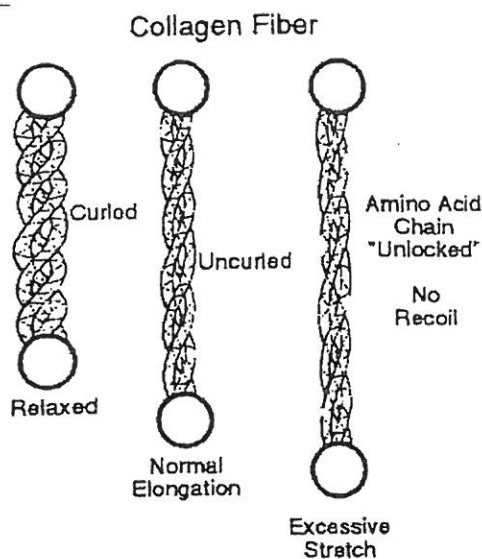


Figure 1 Collagen can stretch a little bit before it breaks.

are molecules of collagen. (See Fig. 1) Loose ligaments allow the joint to move beyond its normal range of motion. (Greenman) The abnormal motion allowed by the strained ligament will produce painful sensations and make you aware of the problem. These sensations also include feeling of "numbness and tingling" and a phenomena of referred pain. This referred pain is created by the ligament laxity around a joint but is felt at some distance from the injured joint. The abnormal joint movement also creates many protective actions by adjacent tissues. Muscles will contract in an attempt to pull the joint back to the correct location or to stabilize it, and protect it from further damage. We then feel the **muscle spasms** which are related to the ligamentous laxity. There is a tendency to treat the muscle spasms as the primary cause of the problem and many medical treatments may be directed toward the muscular spasms, and not to the primary cause—the ligamentous strain. (Cyriax) If the joint is slightly out of place because of the ligamentous laxity, it may respond to manipulative care. Such manipulative techniques will often give good relief and sometimes permanent relief.

If **lax ligaments** can lead to muscle spasm, loss of movement, and all sorts of painful sensations and feelings, what can be done? The only non surgical treatment for this ligamentous strain or laxity problem is called **PROLOTHERAPY**. In order to understand prolotherapy, one must understand how the body heals ligament damage normally. This healing process is called **inflammation**.

INFLAMMATION—HEALING THE BODY

Inflammation has several distinct phases, the acute inflammation phase, the granulation phase, and the remodeling phase. This “Healing Cascade” is basic to all injuries regardless of the site or tissue. These three phases, each have their own cellular and chemical processes and changes. Each phase is dependent upon the previous phase for initiation of the next step. (Clark) Understanding inflammation is key to gaining an insight into how prolotherapy works. See figure 2.

The first phase is called, acute inflammation and is about one hundred hours long. This step begins at the time of the injury, when the ligament and the adjacent cells are broken open and their contents spill at the wound site. The ligamentous and cellular debris and a number of chemicals in the fluid or plasma around the broken-open cells attract an influx of white blood cells called leukocytes. Their job is to clean out the bacteria and prevent infection at the injury site. Many of the chemicals released during this phase will be broken down into messengers or chemical signals that tell cells to become active or inactive during this phase of inflammation. Some of these chemicals are called prostaglandins, which can cause pain at the injury site. More about them later. The leukocytes also secrete hormones which attract an important cell called the “macrophage”. The arrival of the macrophages at the injury site signal the beginning of the next phase in the healing process—the granulation phase. As the macrophage arrive at the injury site they begin to “clean up” the area through a combination of digesting the broken-down cell parts and secreting enzymes which break down many of the damaged ligament molecules.

The macrophage also release a number of hormones which will bring more cells to the injury site. The macrophage also release chemicals (growth factors) which stimulate the growth of new blood vessels, intercellular matrix, and the cells that will make new ligaments. These specialized cells which make ligaments are called **fibroblasts**. The fibroblasts, will be responsible for the actual repairing of the sprained ligament. The combination of all of these cells, and the new blood vessels being formed causes the thickness and fullness that can be felt at the injury site. The granulation phase will be present for ten days to two weeks. Fibroblasts will find the site where the ligamentous structures attach to the bone—the fibro-osseous junction. The fibroblasts will be stimulated or “turned on” to make new ligaments by chemicals and hormones that have been released by the incoming clean up cells, the macrophage. When the fibroblast are “turned on” they rapidly make massive amounts of the basic building blocks of ligaments—collagen. The third phase of healing is called “wound contraction”. During this phase the new collagen deposited at the injury site will be organized into a new ligament. The fibroblasts make single long molecules which when outside of the cell will begin to entwine around each

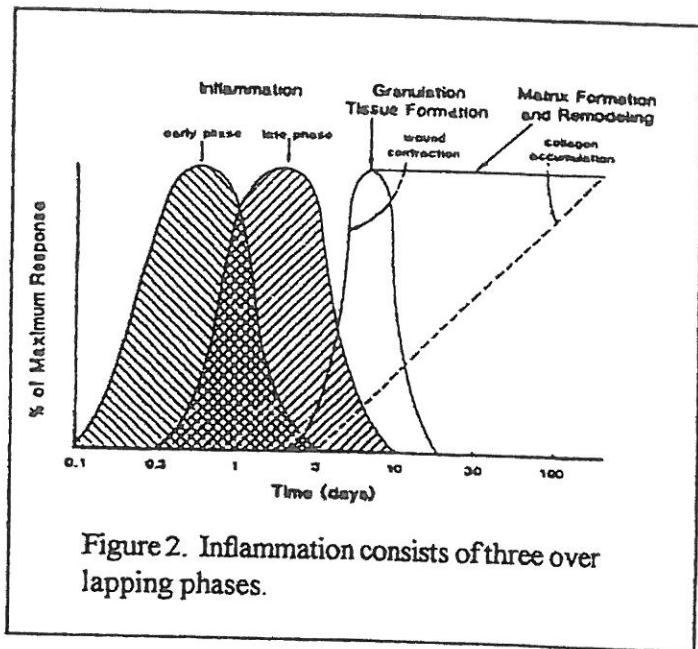


Figure 2. Inflammation consists of three overlapping phases.

other forming what we call a collagen fiber which is a "triple helix" of these molecules. The individual molecules are held together by strong chemical bonds. As the collagen fibers wind around each other they begin to contract and the molecules become shorter and tighter, water is squeezed out (like squeezing a sponge) which also causes shrinkage. As the millions of collagen fibers lose water and shrink, the ends of the ligament will be slowly pulled together and the laxity will decrease.

We can see this in the healing of a skin wound, as the edges of the wound pull tightly together near the end of the healing process. This process is summarized in Figure 2. During the third phase of the healing process, all of the cells originally present to "clean up" the wound are recalled by the body. All that is left at the injury site are the fibroblasts which have been "turned on" and are secreting the collagen and other substances which will be used to increase the integrity of the injury site. This third phase of inflammation lasts for a number of weeks, and the "new ligament" tissue will not reach its maximum strength for several months.

LIGAMENT INJECTION THERAPY

Now that it is understood how inflammation and collagen works, we can really understand what we need to do to create inflammation. Ligament injection therapy simply stimulates this healing process in a more controlled and less violent way than occurs during trauma in an automobile accident, slip or fall, twist or athletic injury. The technique of creating this inflammation and the creation of collagen is done by injecting proliferants.

Proliferants are nothing more than irritants. These irritants are enough to break open the surface of the cell walls and allow the spilling out of their contents into the immediate and adjacent tissue spaces near where the fibroblast reside at the junction of the ligament and the bone. This then stimulates the healing cascade. A number of different proliferants may be used which are capable of causing this process. The most frequently used in my office are osmotic shock agents. These drugs are dehydrating agents, and are going to remove the fluids from the cells around the injection site. In the modern orthopaedic medicine practice, this osmotic shock agent is primarily a concentrated solution of glucose, glycerine and a very small amount of phenol. It is called "P2G". Sodium morrhuate is another frequently used proliferant. This drug is the same long fat molecule that makes up the cell wall. When injected in dilute amounts it stimulates the production of the prostaglandins or the chemical messengers of inflammation. Sodium morrhuate is extracted from cod liver oil, and has the same chemical formula as arachidonic acid. All of these proliferants are injected at the fibro-osseous junction with a large amount of local anesthetic, usually Procaine.

The discomfort of prolotherapy, because it is an "artificial" injury, is an important signal that healing is underway. The pain, swelling, heat and the redness caused by the injections are all signs that the underlying cellular and chemical processes of 200 million years of evolution are safely underway. The body's pain signals can be listened to, and as the pain decreases the joint movement can increase.

Why is this secondary treatment needed? If this process is a natural one in the body, why did it not do the job correctly the first time? Orthopaedic medical physicians do not understand all the reasons. Some of the more likely causes are: Initially, there was continued joint displacement following the injury and the

ligament healed in the "longest possible length" position, the nutrition of the patient during healing was inadequate, the genetic tendencies to heal are not complete, or that the healing process was itself suppressed by such medications as aspirin. Aspirin and other nonsteroidal anti-inflammatories (NSAID's) can knockout or suppress the healing response by interfering with the prostaglandin-growth factor pathways. These drugs are frequently prescribed because they are thought to be safe and a conservative treatment modality. However, research has shown that aspirin is not without significant side effects concerning inflammation. In addition to well documented adverse effects this medication has upon healing in the stomach, they may directly inhibit the healing of injured ligaments.

LIGAMENT INJECTION THERAPY IS 2500 YEARS OLD

Prolotherapy is not a new technique, Prolotherapy was first used by Hippocrates on Olympic javelin throwers who occasionally dislocated their shoulders. It was used to treat hernias before modern surgical techniques became available. The techniques I use were where developed in the 1930's by M.D.'s and a D.O.'s. (Hackett) The same techniques and drugs have been used successfully for pain relief from ligament laxity for nearly sixty years. Prolotherapy is now gaining wider acceptance for painful musculo-skeletal and ligamentous problems and has demonstrated long lasting results. (Klein)

THE RISKS OF LIGMENT INJECTION THERAPY

Treatment with prolotherapy is not without risk. Since the intent of the technique is to create inflammation, pain, swelling, and redness, the result can sometimes be more than anticipated. The injections are also painful because the placement of the needle at the fibro-osseous junction, is also a tender site. Since the skin is broken with a needle infection is a possibility, but very few infections have been reported. Serious complications are very rare. Deaths have been reported from prolotherapy, but none in the last 25 years. Prolotherapy has proven a safe therapeutic technique in well trained hands, but is not easy to learn. The prolotherapist must have training in the form of workshops, apprenticeships, and be a true student of functional anatomy. Prolotherapy done by trained hands is an effective treatment method for the pain and dysfunction of ligaments laxity. (Schwartz)

SUMMARY

In summary, accidents which cause ligament strains are normally healed by a process called inflammation. Inflammation is a multi-phased process, but the end product is the production of collagen which will form the threads of a new ligament. As the collagen loses water, it shrinks, becomes shorter and tends to pull the two ends of the ligament together. If this process is incomplete, the joint may remain in an abnormal position and this causes pain, numbness, and muscle spasms.

Prolotherapy is an injection technique whereby drugs are injected at the fibro-osseous junction, which causes inflammation and the subsequent stimulation of fibroblast to make new collagen fibers. The technique is painful but safe and effective in decreasing the pain of abnormal joint movement or ligament laxity.

REFERENCES:

Cailliet R. Neck and Arm Pain, F.A.Davis, Philadelphia, 1991.