



# PERINEURAL SCAR TISSUE

## WHAT IS SCAR TISSUE?

Scar tissue is the body's natural fibrous response to healing destroyed or damaged tissue. It is fibrous tissue that forms when normal tissue is damaged or destroyed by disease, injury, or surgery. It's made of dense collagen fibers. It is often rigid and much less elastic than healthy tissue. When it forms deep inside the body, it can create internal bands called adhesions. These adhesions can bind organs and different structures together. If you were to hold a piece of scar tissue in your hand, it would have a dense, gristly, and rubbery texture. If you tried to squeeze it, it would feel incredibly stubborn—more like a piece of dense leather or dried hot glue. If you pulled it from both ends, it wouldn't stretch at all.

## WHY IS IT A PROBLEM?

After surgery, excess scar tissue can sometimes form around the nerves (known as **perineural fibrosis** or **perineural scar tissue**) and result in new compression of the nerves. This scar tissue can squeeze the nerves or bind them to nearby tissue since the brachial plexus sits in a very tight space alongside numerous other structures such as muscles, tendons, bones and vessels. If bad enough, this new compression of the nerves can result in a recurrence of TOS symptoms. The good news is that the chance of having a scar tissue recurrence that is bad enough to need another surgery or major intervention is low – only around **5%**. The risk of perineural scar tissue is highest during the first two years after surgery, and about **80%** of scar tissue recurrences occur during this timeframe as this is when the nerves are still actively healing and are at their most vulnerable and fragile state.

## WHAT ARE THE RISK FACTORS FOR POST-OP SCAR TISSUE?

Scar tissue is a natural part of how the body heals from any nerve damage. While standard surgery always creates *some* scar tissue, it usually isn't enough to cause a problem. However, if the nerves sustain further damage or irritation during recovery, the body overreacts by producing **excess** scar tissue—and that extra buildup is what leads to new nerve compression. Outlined below is a list of things that can lead to excess perineural scar tissue.

- Having a genetic predisposition to form excessive amounts of scar tissue or having a medical condition that causes the body to create excessive scar tissue.
- A new injury like a fall or accident involving the head, neck, shoulder or arm which reignites the healing process in the surgical area
- Doing too much too soon after surgery particularly the typical TOS aggravating activities such as repetitive tasks (typing, mousing), overhead tasks, lifting too much weight, tasks requiring a lot of fine motor skills (writing, typing, sewing, etc.). Basically, anything that causes the nerves to be overworked during the healing process when they are most vulnerable. This can also include aggressive or inappropriate physical therapy, especially strengthening or resistance.
- Post-Operative Fluid Collection: complications like a hematoma, or the absence of a surgical drain, can cause fluid to accumulate around the surgical site. This stagnant fluid irritates the nearby nerves.

## HOW DOES OVERWORKING OR OVERUSING THE NERVES RESULT IN SCAR TISSUE?

Unfortunately, our body cannot undertake any task or activity without nerves being involved. They tell our muscles what to do and provide strength for them to be able to carry out their tasks. And just like everything else in our body, nerves need rest to heal. Post-operative nerves are incredibly fragile, irritated, and inflamed. Overusing them through premature or excessive activity can worsen and prolong this inflammation; over time, chronic inflammation can lead to the formation of perineural scar tissue. Think of it this way: if you have a broken ankle and you keep walking a mile every day, it's going to take a lot longer to heal, it probably won't heal properly and will probably sustain more damage. It's very similar with nerves.

Nerves are designed to lengthen and stretch slightly during normal movement. But when they are stretched beyond their usual range to perform tasks, blood flow decreases significantly. After surgery, overusing already irritated nerves means that they are being repeatedly stretched while also receiving less blood flow. That combination can damage the nerves, and scar tissue may form as part of the healing response. After nerve surgery, increased tension within the nerves' gliding pathways can make stretching and elongation even more difficult than in healthy nerves. Friction between healing nerves and the surrounding tissues during movement can also cause damage leading to additional perineural scar tissue.

## WHY PHYSICAL THERAPY DOES NOT PREVENT PERINEURAL SCAR TISSUE

It's a common misconception that, after NTOS surgery, doing physical therapy can prevent scar tissue from forming around the nerves. Many people hear this from physical therapists and get the impression that they need to begin PT right away to help prevent scar tissue. However, this is simply not true, and, in fact, the opposite is true – PT can actually **cause more scar tissue to form** around the nerves. Because TOS is rare and brachial plexus surgeries aren't super common, most physical therapists are mainly used to working with patients after joint, muscle or tendon surgeries. Physiologically, joints, muscles, and tendons are **VERY** different from nerves. They are biomechanical tissue, and nerves are neurological tissue. The difference in how physical therapy affects a healing joint versus a healing nerve comes down to how cells respond to mechanical force and the physical tolerance of the tissues involved.

Surgical trauma to a joint and its surrounding ligaments causes fibrin to collect around the joint capsule. If you don't get the joint moving quickly, this fibrin and scar tissue build up, locking the joint down and making movement incredibly painful. Because muscles, joints, and tendons are designed to be stretched and loaded, starting physical therapy right away is vital. The mechanical force of therapy actively rearranges the scar tissue, aligning it with the natural patterns of movement to keep the joint moving freely.

Unlike muscles and joints, nerves are **not** built to be stretched, pulled, or loaded. Nerves have only a tiny amount of "give" for basic movement and cannot handle mechanical force. Because of this, physical therapy cannot be used to break up or realign scar tissue around a nerve without risking serious damage. If a nerve is irritated from surgery, attempting to move it too aggressively or too soon can create friction between the nerve and its surrounding tissues which can cause damage to the nerve and thus result in additional dense scar tissue forming around the nerve. If a nerve is already irritated from surgery, aggressive movement creates friction against surrounding tissue, causing further irritation and producing even denser scar tissue. In the tight quarters of the brachial plexus (as with

NTOS), this extra scar tissue can not only squeeze the nerve itself, but it can also easily glue the nerve to nearby bones, blood vessels, muscles, or even other nerves—causing new compression and a return of TOS symptoms. Therefore, protecting the nerves from excess scar tissue depends on surgical skill, surgeon protocols including nerve wrapping, anti-inflammatory care, and strict adherence to post-op restrictions, rather than physical stretching.

## HOW DO WE PREVENT IT?

**Surgeons can help prevent perineural scar tissue in the following ways:**

- Using gentle neurolysis methods
- Using a drain that moves the surgical drainage away from the brachial plexus
- Minimizing bleeding by using appropriate hemostatic agents & methods
- Using nerve wraps to wrap the brachial plexus nerve roots

**The patient can help prevent perineural scar tissue in the following ways:**

- Strict adherence to all post-op activity restrictions
- Avoiding and using caution with the typical TOS aggravating activities such as repetitive tasks (typing, mousing), overhead tasks, lifting too much weight, tasks requiring a lot of fine motor skills (writing, typing, sewing, etc).
- Slowly progressing activity as tolerated
- Preventing secondary injuries
- Being proactive with Physical Therapy boundaries and listening to your body. Don't do anything that hurts or causes a significant flare of symptoms, especially nerve symptoms. It's perfectly acceptable to take a step back from PT if your nerves need it. It's better to be safe than sorry!
- Always check in with your surgeon if you are unsure about the safety of a specific activity or your body's and nerves' reactions to the same – including physical therapy!