Spine University's Guide to

Neuroplasticity and Chronic Pain

Spine University Education for life.

Introduction

Neuroplasticity is also called *Brain Plasticity*. Neuroplasticity is the ability of your brain to reorganize *neural* (nerve) pathways in the brain. In simple terms, every time you learn how to do something, you are unconsciously memorizing the process of how it's done and what the outcome will be. As you learn, your brain is making subtle changes to accommodate the new information and ability. Neuroplasticity is generally a good thing and allows us to survive. However, there can be negative consequences from time to time.

What is neuroplasticity?

Neuroplasticity occurs mainly in one of two ways. From birth, you learn new things, from smiling to eating to driving, and more. The second is from adapting. For example, if you are right-handed but you break that hand or lose its function, you need to adapt and learn to use how to complete tasks with your left hand.

What does chronic pain have to do with neuroplasticity?

As research techniques become more refined, researchers are able to study the human brain and its function in living people, rather than waiting for an autopsy. Up to now, researchers have been able to establish the existence of a network of pain-transmitting areas within the central nervous system (CNS). This was first demonstrated with animals and, more recently, by performing brain studies with humans.

Chronic pain is pain that has been present, either continually or off and on, for at least three to six months, depending on the physician. Chronic pain is complex and often difficult to pinpoint and treat, unlike *acute* pain. Acute pain is a sudden pain that can usually be identified and treated, such as a toothache, stubbing your toe, or having surgery.

Chronic pain is very common among North American adults. Data from 1999 show that approximately 25 million people visit a doctor because of acute pain, while about 50 million seek help for chronic pain. Chronic pain affects people's lives because it can cause other physical problems, affect the ability to work and enjoy life, and it can affect the social and economic status of people. Chronic pain causes lost productivity and increases health care costs.

Where neuroplasticity comes in is when acute pain develops into chronic pain. Your body reacts to acute pain as it warns you that something is wrong. Usually, once the acute pain has been dealt with, either with medications or other treatments, the pain goes away and becomes a distant memory. However, over the course of a few weeks, months, and sometimes even years, your brain's "wiring" may reorganize itself and tell your body that the chronic pain should be there and will stay there.

How this change occurs is different from person to person. Some people unknowingly encourage the development of chronic pain through their reactions to the original acute pain. For example, if you have hip or leg pain on the right side, you may try to protect that area from more pain by leaning more to the left side. This puts more weight on your left leg and hip, and tilts your pelvis. It also puts more pressure on the muscles.

As the pain on the right side fades, the left leaning position may have become a habit and it may also have begun to cause pelvic or back pain from the altered position. The result? You unwittingly caused your body to develop pain pathways and the pain in your back and pelvis may become more bothersome than the original acute pain was.

How do researchers find this type of information?

Magnetic resonance imaging (MRI) was developed in the late 1900s and this type of imaging has a large advantage over *computed tomography* (CT) scans and x-rays because MRIs use magnets to make images, rather than radiation.

Using powerful magnets, radio frequencies, and a computer, doctors can see detailed image of inside the body from many different angles. MRIs revolutionized medicine because they allowed not only a better view of the body organs, researchers could use MRIs to examine the brains of patients while they were experiencing pain.

In the course of research into issues like neuroplasticity, using MRIs allows researchers to understand the relationship between the brain's structure and its function. Of course, there are still many limitations as to what researchers can actually observe, but the presently available technology is a good step forward.

Chronic back pain and neuroplasticity

Chronic back pain, particularly of the lower back, is the most common complaint of pain the developed world, even more than headaches and migraines. It's estimated that 70 to 85 percent of people in developed countries have had, have, or will have chronic lower back pain at some point in their lifetime.

The connection between back pain and brain function has interested researchers for quite a while. In 2004, A.V. Apkanian and colleagues analyzed 17 patients who complained of chronic back pain. After examining the patients' brains, the researchers found that the patients had some brain *atrophy* (wasting away of tissue) in the brain. The researchers wrote that they believed the atrophy wasn't due to tissue shrinkage, but was due to *neurodegeneration*, degeneration of the neurons.

Other researchers, such as T. Schmidt-Wicke, agreed with Apkarian when that team studied 18 patients and matched them with controls, people without chronic back pain. The researchers found the same decrease in brain tissue among those patients who had pain, but not in the controls.

It would make sense that the length of time that pain is felt would increase in relation to the decrease in brain tissue, but that doesn't always appear to be the case.

Phantom pain and neuroplasticity.

Phantom pain is a mysterious type of neurological pain. It happens when a part of your body is amputated but your brain still senses pain in that area. The pain can be a mild ache or it can be very severe. There are even cases of people feeling phantom pain after a mastectomy or after an organ has been removed.

For some, the phantom pain goes away with time. But, for others, it never goes away. It’s less common in the lower limbs (legs and feet), with about 54 percent of patients reporting phantom pain, but more in the upper limbs (arms and hands), with about 82 percent reporting pain.

There is also *phantom limb sensation*, which causes you to feel the presence of the missing limb. This isn't considered painful though. It's estimated that up to 98 percent of people who have had a limb amputated feel this.

In animal studies, researchers have found that the brain does try to reorganize itself after nerves have been cut, as would happen from an amputation. But, not much research has been done into the structural changes in the brain after an amputation.

Two animal studies did lead researchers to believe that there are different areas in the human brain that can change, including the *brain stem*. The brain stem is the part of the brain that helps you be conscious of your surroundings. There are also changes in the *thalmus*, which plays a role in sleep and wakefulness, and the *somatosensory cortex*, which interprets the sensations, such as cold and heat.

A recent study on humans took this earlier information and expanded on it. Researchers studied the brains of 28 patients who had lost one limb and compared them with people who had all their limbs. The results of the study showed that there was a physical change in the gray matter in the brain, a decrease in the thalmus area, of the patients who had had an amputation, but not in the control patients. By analyzing the changes in connection with how long the changes took to appear following the amputation, the researchers found that there was a *maladaptive plasticity* that may result in pain memory.

Chronic headaches and neuroplasticity

Although most people get the occasional headache, there are people who experience headaches for more than 15 days (or more) each month. They are said to have *chronic headaches*. It is estimated that between three to five percent of people worldwide have chronic headaches.

There are several subtypes of chronic headaches, such as chronic migraine, chronic tension-type headache, medication overuse headache, and *hemicrania continua* (a headache that only affects one side of the face and head).

The most common subtypes are the chronic tension type and the medication overuse type. There is a significant difference between the two headaches though. While it's difficult to treat the tension type headaches, it's relatively simple to treat the medication overuse headaches. These headaches go away if the patient stops taking analgesics (pain killers).

Researchers examined the brains of people with either tension type headache or medication overuse headaches and compared them with people who didn't have headaches. The researchers found that neither patients with medication overuse headaches nor the controls had any changes in brain tissue, but patients with tension type headaches did. And, the longer the patients had their headaches, the more tissue was lost in the brain.

While investigating patients with episodic headaches and patients with tension type headaches, researcher M.S. Matharu and colleagues fond that patients with episodic headaches didn't have any brain changes, while, as expected, those with tension type headaches did have changes. These findings were challenged by other researchers who came up with different findings.

Migraines and neuroplasticity

Migraines are more than just severe headaches. Migraines are in a class by themselves. The only thing they have in common with headaches is the head pain. A migraine usually, but not always, involves a severe, unilateral (one-sided) headache that is often described as pulsing or throbbing. In addition to the pain, many people with migraines also become very sensitive to light (photophobia), sounds, and odors. They may also be nauseous and vomit.

Many studies have been done on migraineurs, people who have migraines. This research has shown that there are changes in the brains of migraineurs, much like those with other chronic pain. Although there hasn't been a connection made between the changes in the brain as a result of the pain, researchers have found that these changes may actually have a part in causing the migraine pain.

M.A. Rocca and colleagues studied 16 patients with migraines and they also found changes in their brain tissue. Two other studies compared patients with migraines to control subjects who didn't have migraines. Both studies also found brain changes in the migraineurs.

When interpreting the study data, Rocca's group suggested that the changes could have been caused by the repeated pain attacks on the brain. However, the pattern of the tissue changes seemed to be more in line with the idea that they are caused by the duration of pain, not the frequency. An interesting issue though is that migraines tend to come less often as people age and researchers aren't sure how this is connected to the changes in the brain.

Fibromyalgia, irritable bowel syndrome, and neuroplasticity

Fibromyalgia is a little understood illness that still has the stigma of not being a real disease to many people. However, people who do have fibromyalgia would argue that the reality of their life with fibromyalgia includes pain, stiffness, fatigue, and difficulty sleeping.

Perhaps studies of the brain changes and chronic pain may help researchers and doctors better understand illnesses like fibromyalgia. The latest research is suggesting that fibromyalgia has a connection with the central nervous system and is the result of a malfunction, or dysfunction, of the central nervous system.

A. Kuchinad and colleagues studied 10 women who had fibromyalgia and compared them with 10 women who did not have the illness. Among the women with fibromyalgia, Kuchinad's team found a reduction in brain tissue that wasn't found in the controls. This finding was backed up by yet another study not long after.

Irritable bowel syndrome (IBS) is another syndrome that has its skeptics. There is no test for IBS (nor for fibromyalgia). Diseases that have no tests are diagnosed through exclusion. This means that doctors must do tests to rule out all other possibilities and IBS is only diagnosed when all other illnesses are ruled out.

People with IBS experience pain and cramping, and diarrhea or constipation, or both. As with fibromyalgia, brain imaging of patients with IBS has found a loss in brain tissue and the patterns are very similar to fibromyalgia and other chronic pain issues.

Do people with chronic pain then have the same brain changes?

Eight studies that looked at the shape and changes in brain tissue point to the issue that there is a connection between neuroplasticity and chronic pain. However, the changes – loss of gray matter – appear to be from pain memory, not pain-related activity (or inactivity) or medications. It appears that no matter what is causing the chronic pain, the same changes are taking place in the brain and in the same areas. This being said, there is a lot more research that needs to be done to see if there are other factors involved in these changes and how the rest of the neurological system may play a role.

An interesting finding is of the loss of gray matter in regions of the brain that are responsible for suppression or lessening of painful sensations. This could be one of the reasons why chronic pain becomes such an issue: the body no longer knows how to relieve the pain or how to feel the sensation of lessened pain.

So, why do some people experience chronic pain and not others? That's a question that has been puzzled over for generations. Some theories include that there is a genetic issue, something that runs in families, but there isn't much proof to say that this is truly a possibility.

Further research will be done in how brain tissue atrophies and why. What is actually causing the brain cell shrinkage or loss? Until this is understood, researchers can't approach treatment or cures from this angle. But if they do learn how and why, then a treatment that may be able to reverse the brain tissue loss may be in the future.

Notes