



## Spinal cord stimulation

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### Overview

Spinal cord stimulation is a therapy that masks pain signals before they reach the brain. A small device, similar to a pacemaker, is implanted in the body to deliver electrical pulses to the spinal cord. It helps patients better manage their chronic pain symptoms and decrease the use of opioid medications. It may be an option if you suffer chronic back, leg or arm pain and have not found relief with other therapies.

### What is a spinal cord stimulator?

A spinal cord stimulator (SCS) device is surgically placed under your skin and sends a mild electric current to your spinal cord (Fig. 1). A small wire carries the current from a pulse generator to the nerve fibers of the spinal cord. When turned on, the SCS stimulates the nerves in the area where your pain is felt. Pain is reduced because the electrical pulses modify and mask the pain signal from reaching your brain.

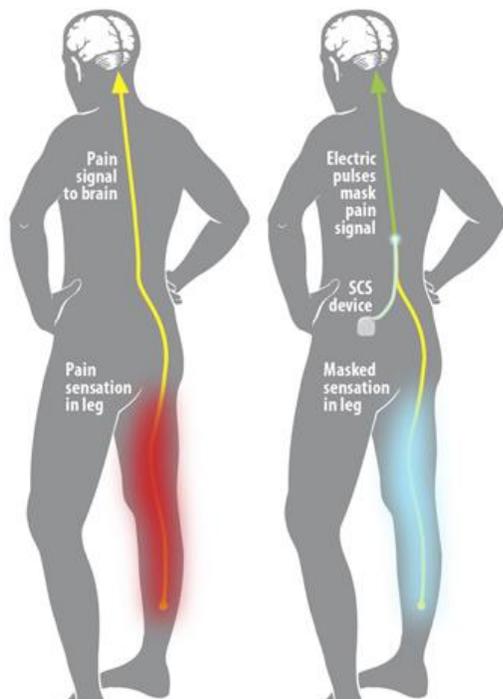


Figure 1. A spinal cord stimulator works by masking pain signals before they reach the brain. A stimulator device delivers electric pulses to electrodes placed over the spinal cord. Modified by the pulses, the pain signals are either not perceived or are replaced by a tingling feeling.

Stimulation does not eliminate the source of pain, it simply interferes with the signal to the brain, and so the amount of pain relief varies for each person. Also, some patients find the tingling sensation unpleasant. For these reasons a trial stimulation is performed before the device is permanently implanted. The goal for spinal cord stimulation is a 50-70% reduction in pain. However, even a small amount of pain reduction can be significant if it helps you to perform your daily activities with less pain and reduces the amount of pain medication you take. Stimulation does not work for everyone. If unsuccessful, the implant can be removed and does not damage the spinal cord or nerves.

Some SCS devices use a low-frequency current to replace the pain sensation with a mild tingling feeling called paresthesia. Other SCS devices use high-frequency or burst pulses to mask the pain with no tingling feeling. A paresthesia-free setting is an option on most devices.

Stimulation does not eliminate the source of pain. It simply changes the way the brain perceives it. As a result, the amount of pain relief varies for each person. The goal for SCS is a 50 to 70% reduction in pain. However, even a small amount of pain reduction can be significant if it helps you perform daily activities and reduces the amount of pain medication you take. SCS does not improve muscle strength.

Stimulation does not work for everyone. Some patients may find the sensation unpleasant. In other cases it may not cover the entire pain area. For these reasons a trial stimulation is performed before the device is permanently implanted. If unsuccessful, the trial wires can be removed, leaving no damage to the spinal cord or nerves.

There are several types of SCS device systems. However, all have three main parts:

A pulse generator with a battery that creates the electrical pulses.

A lead wire with a number of electrodes (8-32) that delivers electrical pulses to the spinal cord.

A hand-held remote control that turns the device on and off and adjusts the settings.

Systems with a non-rechargeable battery need to be surgically replaced every 2 to 5 years, depending on the frequency of use. Rechargeable battery systems may last 8 to 10 years or longer, but the patient must charge the system daily.

The pulse generator has programmable settings. Some SCS devices are able to sense a change in body position (sitting vs. lying down) and adapt the stimulation level to your activity. Other systems have leads that can be independently programmed to cover multiple pain areas. Some send a sub-perception pulse with no tingling. Your doctor will select the best type of system for you.

## Who is a candidate?

An evaluation of your physical condition, medication regime, and pain history will determine whether your goals of pain management are appropriate for SCS. A neurosurgeon, physiatrist, or pain specialist will review all previous treatments, including medication, physical therapy, injections, and surgeries. Because chronic pain also has emotional effects, a psychologist may assess your condition to maximize the probability of a successful outcome.

Patients selected for SCS usually have had chronic debilitating pain for more than 3 months in the lower back, leg (sciatica), or arm. They also typically have had one or more spinal surgeries.

You may be a candidate for SCS if :

Conservative therapies have failed.

You would not benefit from additional surgery.

The pain is caused by a correctable problem and should be fixed.

You do not want further surgery because of the risks or long recovery. Sometimes SCS may be chosen over a large, complex spine surgery.

You do not have untreated depression or drug addiction; these should be treated prior to having a SCS.

You have no medical conditions that would keep you from undergoing implantation.

You have had a successful SCS trial.

SCS works better in the earlier stages of a chronic condition, before a cycle of pain-suffering-disability-pain is established.

An SCS can help lessen chronic pain caused by:

**Chronic leg (sciatica) or arm pain:** ongoing, persistent pain caused by degenerative conditions like arthritis or spinal stenosis, or by nerve damage.

**Failed back surgery syndrome:** failure of one or more surgeries to relieve persistent arm or leg pain (sciatica), but not a technical failure of the original procedure.

**Complex regional pain syndrome:** a progressive disease of the nervous system in which patients feel constant, chronic burning pain, typically in the foot or hand.

**Arachnoiditis:** painful inflammation and scarring of the protective lining of the spinal nerves.

**Other:** stump pain, angina, peripheral vascular disease, multiple sclerosis, or spinal cord injury.

## Who performs the procedure?

Neurosurgeons and doctors who specialize in pain management (an anesthesiologist or physiatrist) implant spinal cord stimulators.

## The surgical decision

Determining whether a spinal cord stimulator will be a good option for you is a two-step process. First, you must undergo a temporary trial to see if the device decreases your level of pain.

### Stage 1. Trial SCS

Trial stimulation is a "test drive" to determine if an SCS will work for the type, location, and severity of your pain. It is performed at an outpatient center.

If you take blood-thinners, you are required to stop the medication 3 to 7 days prior to the trial.

A local anesthetic is given to numb the area in the lower back. Using X-ray fluoroscopy, a hollow needle is inserted through the skin into the epidural space between the bone and spinal cord. The trial lead is inserted and positioned over specific nerves. The wires are attached to an external generator worn on a belt.

You will be sent home with instructions on how to use the trial stimulator and care for your incision site. Keep a written log of the stimulation settings during different activities and the level of pain relief. After 4 to 7 days, you will return to the doctor's office to discuss permanently implanting the stimulator or removing the trial leads.

### Stage 2. Permanent SCS

If the trial is successful and you experience greater than 50% improvement in pain, surgery can be scheduled to permanently implant the SCS.

## What happens before surgery?

You may be scheduled for presurgical tests (e.g., blood test, electrocardiogram, chest X-ray) several days before surgery. In the doctor's office, you will sign consent and other forms so that

the surgeon knows your medical history (allergies, medicines/vitamins, bleeding history, anesthesia reactions, previous surgeries). Discuss all medications (prescription, over-the-counter, and herbal supplements) you are taking with your health care provider. Some medications need to be continued or stopped the day of surgery.

Stop taking all non-steroidal anti-inflammatory medicines (Naprosyn, Advil, Motrin, Nuprin, Aleve, etc.) and blood thinners (Coumadin, Plavix, etc.) 1 to 2 weeks before surgery as directed by the doctor. In addition, stop smoking, chewing tobacco, and drinking alcohol 1 week before and 2 weeks after surgery, because these activities can cause bleeding problems. No food or drink is permitted past midnight the night before surgery.

### Morning of surgery

Shower using antibacterial soap. Dress in freshly washed, loose-fitting clothing.

Wear flat-heeled shoes with closed backs.

If you have instructions to take regular medication the morning of surgery, do so with small sips of water.

Remove make-up, hairpins, contacts, body piercings, nail polish, etc.

Leave all valuables and jewelry at home (including wedding bands).

Bring a list of medications (prescriptions, over-the-counter, and herbal supplements) with dosages and the times of day usually taken.

Bring a list of allergies to medication or foods.

Arrive at the hospital 2 hours before your scheduled surgery time (1 hour before at the outpatient surgery center) to complete the necessary paperwork and pre-procedure work-ups. An anesthesiologist will talk with you and explain the effects of anesthesia and its risks. An intravenous (IV) line will be placed in your arm.

## What happens during surgery?

There are two parts to the procedure: placement of the lead in the epidural space of the spine and placement of the pulse generator in the buttock or abdomen. The surgery generally takes 1 to 2 hours.

### Step 1: prepare the patient

You will lie on your stomach on the table and be given light sedation. Next, the areas of your back and buttock are prepped where the leads and generator are to be placed. Local anesthetic will be used to numb the incisions.

### Step 2: place the leads

The electrode leads are inserted with the aid of fluoroscopy (a type of X-ray). A small skin incision is made in the middle of your back (Fig. 2), and the bony vertebra is exposed.



Figure 2. A small skin incision is made in the middle of your back.

A portion of the bony arch is removed (laminotomy) to allow room to place the leads. The leads are secured with sutures in the epidural space above the spinal cord (Fig. 3).

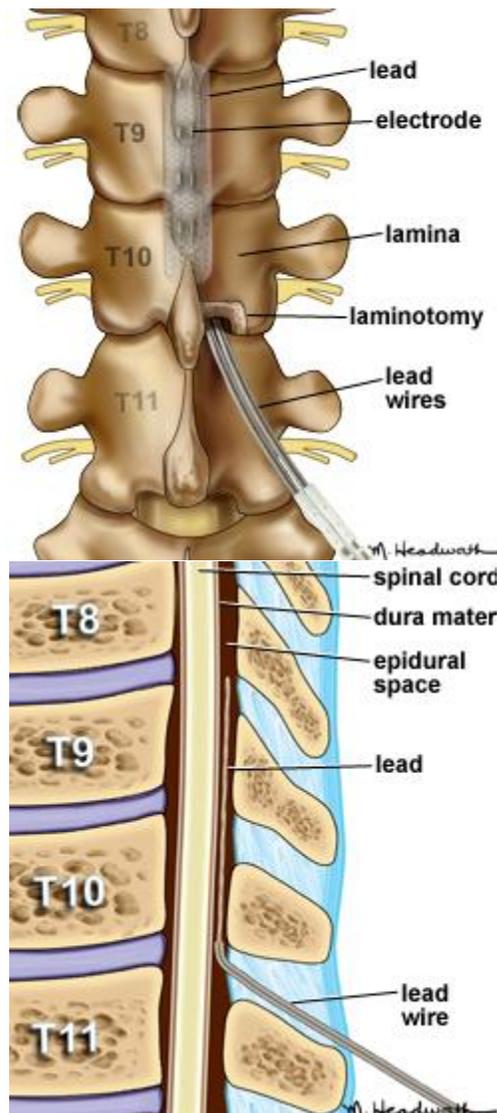


Figure 3. A laminotomy is made in the bony vertebra to allow room to place the leads. The leads are positioned in the epidural space above the spinal cord to deliver electrical current to the area of pain.

### Step 3: test stimulation

You will be awakened so that you can help the doctor determine how well the stimulation covers your pain pattern. Several stimulation settings will be tried, and you will be asked to describe the location of any tingling you feel. These settings will be used to program the pulse generator at the end of surgery, so your feedback is important to ensure the best pain relief.

In some cases, if the leads implanted during the trial are positioned perfectly, there is no need to reposition or insert new leads.

### Step 4. tunnel the wire

Once the leads are in place, sedation is again given. The lead wire is passed under the skin from the spine to the buttock, where the generator will be implanted.

### Step 5. place the pulse generator

A small skin incision is made below the waistline. The surgeon creates a pocket for the generator beneath the skin (Fig. 4). The lead wire is attached to the pulse generator. The generator is then correctly positioned within the skin pocket.

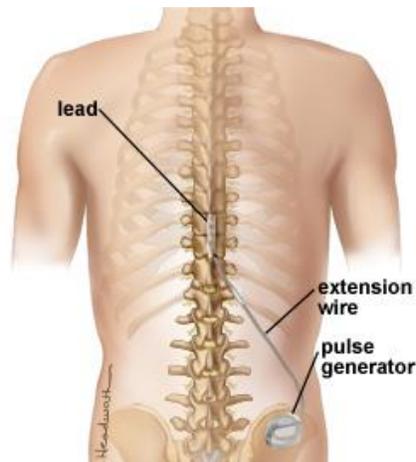


Figure 4. The SCS generator pocket is created below the waist, under the skin of the buttock.

#### Step 6. close the incisions

The incisions are closed with sutures or staples and a dressing is applied.

## What happens after surgery?

You will wake up in the postoperative recovery area, called the **PACU**. Your blood pressure, heart rate, and respiration will be monitored, and your pain will be addressed. Most patients are discharged home the same day or the following morning. The pulse generator will be programmed before you leave. You will be given written instructions to follow when you go home.

## Discharge instructions

### Discomfort

After surgery, pain is managed with narcotic medications. Because narcotic pain pills are addictive, they are used for a limited period (2 to 4 weeks). Their regular use may cause constipation, so drink lots of water and eat high fiber foods. Laxatives (e.g., Dulcolax, Senokot, Milk of Magnesia) may be bought without a prescription. Thereafter, pain is managed with acetaminophen (e.g., Tylenol) and non-steroidal anti-inflammatory drugs (NSAIDs) (e.g., aspirin; ibuprofen, Advil, Motrin, Nuprin; naproxen sodium, Aleve).

Spinal headaches are caused by leakage or loss of cerebrospinal fluid around the catheter or lead site. Lie flat and drink plenty of caffeinated non-carbonated fluids (tea, coffee).

### Restrictions

Avoid these activities for 4 to 6 weeks to prevent movement of the leads:

- do not bend, twist, stretch, reach for faraway objects, pull items toward you, make sudden movements, or lift objects over 5 pounds
- do not raise arms above your head
- do not sleep on your stomach
- do not climb too many stairs or sit for long periods of time

Do not drive for 2 to 4 weeks after surgery or until discussed with your surgeon.

Housework and yard-work are not permitted until the first follow-up office visit. This includes gardening, mowing, vacuuming, ironing, and loading/unloading the dishwasher, washing machine, or dryer.

Postpone sexual activity until your follow-up appointment unless your surgeon specifies otherwise.

### Activity

Gradually return to your normal activities. Walking is encouraged; start with a short distance during the first 2 weeks and then gradually increase to 1 to 2 miles daily.

A physical therapy program may be recommended.

### Bathing/Incision Care

You may shower as directed by your surgeon. Do not take a tub bath or submerge yourself in water for 4 weeks. Pat your incision dry with a soft towel to avoid irritation.

Inspect the incision line twice daily.

Fluid may accumulate under the skin around the leads or the device creating a visible swelling (seroma). Call the doctor if this occurs. Seromas usually disappear by themselves but may require a drain.

Steri-strips or a thin film (skin glue) may cover the incision. After showering, gently pat dry the steri-strips or film. The steri-strips or film will gradually wear off over one to two weeks.

Sutures or staples that remain in place when you go home will need to be removed. Ask your surgeon or call the office to find out when.

### When to Call Your Doctor

If your temperature exceeds 101° F or if the incision begins to separate or show signs of infection, such as redness, swelling, pain, or drainage.

If your headache persists after 48 hours.

If you have sudden severe back pain, sudden onset of leg weakness and spasm, loss of bladder and/or bowel function - this is an emergency - go to a hospital and call your surgeon.

## Recovery

Approximately 10 days after surgery you will come to the office to have the sutures or staples removed. Programming of the pulse generator can be adjusted at this time if needed. It is important to work with your doctor to adjust your medications and refine the programming of the stimulator.

Your pain specialist and device representative will work with you to fine-tune adjustments to the SCS.

## What are the results?

The results of SCS depend on careful patient selection, successful trial stimulation, proper surgical technique, and patient education. Stimulation does not cure the condition that is causing pain. Rather, it helps patients manage the pain. SCS is considered successful if pain is reduced by at least half.

Published studies of spinal cord stimulation show good to excellent long-term relief in 50 to 80% of patients suffering from chronic pain [1-6]. One study reports that 24% of patients improved sufficiently to return to gainful employment or housework with stimulation alone or with the addition of occasional oral pain medication [7].

**SCS therapy is reversible. If a patient decides at any time to discontinue, the electrode wires and generator can all be removed.**

## **What are the risks?**

**No surgery is without risks. General complications of any surgery include bleeding, infection, blood clots, and reactions to anesthesia. Specific complications related to SCS may include:**

**Undesirable changes in stimulation (can possibly be related to cellular changes in tissue around electrodes, changes in electrode position, loose electrical connections, and/or lead failure)**

**Epidural hemorrhage, hematoma, infection, spinal cord compression, and/or paralysis (can be caused by placing a lead in the epidural space during a surgical procedure)**

**Battery failure and/or battery leakage**

**Cerebrospinal fluid leak**

**Persistent pain at the electrode or stimulator site**

**A pocket of clear fluid (seroma) at the implant site**

**Lead migration, which can result in changes in stimulation and reduction in pain relief**

**Allergic response to implant materials**

**Generator migration and/or local skin erosion**

**Paralysis, weakness, clumsiness, numbness, or pain below the level of implantation**

**Conditions for which you might need additional surgery include movement of the lead, breakage of the lead or extension wire, or (in rare cases) mechanical failure of the device.**

**Reasons for removal of the device include infection and failure to relieve pain.**

**Sometimes scar tissue develops around the electrode and can make the stimulation less effective.**

## **Living with a stimulator**

**Once the SCS has been programmed, you are sent home with instructions for regulating the stimulation by controlling the strength and the duration of each stimulation period. Your doctor may alter the pulse width, amplitude, and frequencies on follow-up visits if necessary.**

**The pulse generator has programmable settings:**

- 1. Frequency (rate): number of times stimulation is delivered per second. Too few pulses results in no sensation. Too many results in a washboard or bumpy effect.**
- 2. Pulse width: the area the stimulation will cover.**
- 3. Pulse amplitude: determines threshold of perception to pain.**

**The handheld programmer lets you turn the stimulator on and off, select programs, and adjust the strength of the stimulation. Most people are given multiple programs to achieve the best possible pain relief at any point throughout the day or during specific activities. You can use your spinal cord stimulator around the clock if necessary.**

**Some people feel differences in stimulation intensity depending on their position (e.g., sitting versus standing). This is caused by variations in the spread of electricity as you change positions and is normal.**

**Just like a cardiac pacemaker, your stimulator cannot be damaged by devices such as cellular phones, pagers, microwaves, security doors, and anti-theft sensors. Be sure to carry your Implanted Device Identification card when flying, since the device is detected at airport security gates. Department store and airport security gates or theft detectors may cause an increase or decrease in stimulation when you pass through the gate. This sensation is**

temporary and should not harm your system. However, as a precaution, you should turn off your system before passing through security gates.

The various SCS systems have different restrictions to their use with MRI, ultrasound, defibrillator, electrocautery, diathermy, and cardiac pacemakers. Be sure to know the limitations of your specific SCS device. Also, chiropractic manipulation may cause the lead to move. Consult your surgeon first.

## Sources & links

### Sources

1. Verrills P, Sinclair C, Barnard A. A review of spinal cord stimulation systems for chronic pain. *J Pain Res* 9:481-92, 2016
2. De la cruz P, Fama C, Roth S, et al. Predictors of Spinal Cord Stimulation Success. *Neuromodulation* 18(7):599-602, 2015
3. Grider J, Manchikanti L, Carayannopoulos A, et al. Effectiveness of Spinal Cord Stimulation in Chronic Spinal Pain: A Systematic Review. *Pain Physician* 19:E33-E54, 2016
4. Deer TR, Skaribas IM, Haider N, et al. Effectiveness of cervical spinal cord stimulation for the management of chronic pain. *Neuromodulation* 17(3):265-71, 2014
5. Deer TR, Mekhail N, Provenzano D, et al. The appropriate use of neurostimulation of the spinal cord and peripheral nervous system for the treatment of chronic pain and ischemic diseases: the Neuromodulation Appropriateness Consensus Committee. *Neuromodulation* 17(6):515-50, 2014
6. Eldabe S, Buchser E, Duarte RV. Complications of Spinal Cord Stimulation and Peripheral Nerve Stimulation Techniques: A Review of the Literature. *Pain Med* 17(2):325-36, 2016
7. Sundaraj SR, et al: Spinal cord stimulation: A seven-year audit. *J Clin Neurosci* 12:264-270, 2005

### Links

[www.spine-health.com](http://www.spine-health.com)  
[www.controlyourpain.com](http://www.controlyourpain.com)  
[www.tamethepain.com](http://www.tamethepain.com)  
[www.poweroveryourpain.com](http://www.poweroveryourpain.com)  
[www.nevro.com](http://www.nevro.com)

## Glossary

**laminotomy:** surgical cutting of the laminae or vertebral arch of the vertebra.

**lead:** a small, silicone coated medical wire that has electrodes at one end. Electrical current passes from a battery, along the wire, to the electrodes. Two types: percutaneous and surgical leads.

**fluoroscopy:** an imaging device that uses x-ray or other radiation to view structures in the body in real time, or “live”. Also called a C-arm.

**percutaneous:** by way of the skin (e.g., injection).

**peripheral nerve stimulation:** a surgical treatment for pain in which specific nerves are stimulated rather than the general area of the spinal cord.

**sciatic nerve:** nerve located in the back of the leg which supplies the muscles of the back of the knee and lower leg and sensation to the back of the thigh, part of the lower leg, and the sole of the foot.

**sciatica:** pain that courses along the sciatic nerve in the buttocks and down the legs. Usually caused by compression of the 5th lumbar spinal nerve.

**seroma:** a mass formed by the collection of tissue fluids following a wound or surgery.

**spinal hygroma:** an accumulation of cerebrospinal fluid under the skin, which produces a visible swelling, caused by leakage around a catheter, drain, or shunt.