



# **Treating Spasticity With Selective Dorsal Rhizotomy (SDR)**



**NATIONWIDE CHILDREN'S®**  
*When your child needs a hospital, everything matters.*





## Contents

Spasticity and Spastic Cerebral Palsy . . . . .	4
What Causes Spasticity? . . . . .	4
Spasticity Symptoms . . . . .	4
Spasticity Treatment Options . . . . .	5
What Is Selective Dorsal Rhizotomy (SDR)? . . . . .	6
Who Is a Good Candidate for SDR? . . . . .	6
Benefiting Ambulatory and Non-ambulatory Patients . . . . .	6
Undergoing SDR: The Patient Journey . . . . .	7
Step by Step: The SDR Procedure . . . . .	8
What to Expect: From the Hospital to Home. . . . .	9
Inpatient Rehabilitation (ambulatory patients only) . . . . .	9
Outpatient Physical Therapy . . . . .	9
When to Expect Improved Walking (ambulatory patients only) . . . . .	9
What Are the Benefits of SDR? . . . . .	10
What Are the Risks of SDR? . . . . .	10
The SDR Approach and Experience at Nationwide Children's . . . . .	11
Our Surgical Approach . . . . .	11
Optimizing the Patient and Family Experience . . . . .	11
Questions to Ask Your Child's Doctor About SDR . . . . .	12
Selected Citations. . . . .	12



Spasticity and Spastic Cerebral Palsy

**Spasticity** is a muscle control disorder in which certain muscles are continuously contracted or tightened. It is caused by an imbalance of the signals that are sent from the brain and spinal cord to the muscles in the body. The imbalance causes muscles to be stiff and can make normal movement, speech and walking difficult.

Spasticity affects more than 12 million people worldwide, including about 80% of people with cerebral palsy. People with traumatic brain injuries, stroke, spinal cord injury or other conditions that affect the brain or spinal cord may also experience spasticity.

**Spastic cerebral palsy** is the most common form of cerebral palsy. People with this condition usually have normal intellect and language development, but increased muscle stiffness that they cannot control. The tightened muscles may cause contortion, jerky or stiff movements, and the inability to walk or take care of personal hygiene. Some people also have difficulty speaking and changing positions.

What Causes Spasticity?

Normally, the brain sends signals down the nerves in the spinal cord that tell muscles when to tighten or relax. Without thinking about it, the body uses these signals to control movement, contracting and releasing different muscles to stand up, walk across a room, put on clothes and more.

Motor vs. Sensory Nerves

**Sensory nerves** detect sensations, such as heat, cold, pain, motion, position, pressure balance and more. **Motor nerves** each connect to a specific muscle. When sensory nerves send a message up to the brain, the brain reacts by sending a signal to the motor nerves to contract or relax.

People with spasticity have lost control of part of the connection between the brain and the muscles. A signal gets stuck in the “on” position. This causes certain muscles — usually in the legs, but sometimes in the arms and hands — to remain contracted or tensed.

It is caused by damage to the brain. In cerebral palsy, the part of the brain (the motor cortex) controlling muscle tone and nerve signals to the affected muscles is often damaged irreversibly, meaning true spasticity doesn’t go away on its own.

Spasticity may affect just the upper limbs or just the lower limbs (spastic diplegia), the arm and leg on just one half of the body (spastic hemiplegia), three of the four limbs, or all four limbs (spastic quadriplegia). In some individuals, the small muscles in the tongue, face and vocal chords are also spastic.

Spasticity Symptoms

Symptoms typically affect the legs and/or arms and include:

- Increased muscle tone or rigidity
- Involuntary spasms and contractions
- Permanent contraction of the muscle and tendon
- Overactive reflexes
- Pain or discomfort
- Less ability to function
- Problems with care and hygiene
- Abnormal posture
- Stiff, jerky, or scissor-like movements
- Bone and joint deformities

Spasticity Treatment Options

Once cerebral palsy spasticity has developed, it does not resolve on its own. Treatment is needed when spasticity causes pain, interferes with daily activities or sleep, or leads to less ability to function.

If spasticity is not treated, it can cause changes in the muscles, tendons and ligaments, including muscle wasting and scarring. The muscles can also shorten and restrict range of motion in the joints. When this happens, the short muscles can also pull on the body’s boney structures, leading to bone deformities such as hip dislocation or scoliosis. Persistent spasticity can also cause considerable pain, both from the spasticity of the muscle as well as from the problems spasticity causes, such as joint contortion or deformities.

Spasticity treatment options vary based on patient age, functional ability, severity of the spasticity and the underlying cause. Regardless of the treatment, the goal is to relieve pain and reduce the muscle tension. This can make it easier to get dressed, walk, eat and bathe.

PHYSICAL AND OCCUPATIONAL THERAPY

Frequent stretching and strength exercises to improve flexibility and mobility

BRACES AND CASTS

Temporary stretching and immobilization of an affected joint or limb to improve flexibility and alignment

COLD PACKS

Temporary application of packs to affected spastic muscles for pain relief

ELECTRICAL STIMULATION

Use of current to stimulate nerves, reduce spasticity and improve mobility

MEDICATIONS

Drugs to relax contracted muscles, relieve pain, improve sleep or support other normal daily functioning

SELECTIVE DORSAL RHIZOTOMY (SDR)

A one-time surgery to snip spastic nerves, which preserves muscle strength and relieves spasticity

IMPLANTED DEVICES

Insertion of an under-the-skin device that pumps steady doses of a muscle relaxer (such as baclofen) to reduce spasticity and side effects of oral drugs. For children who receive a baclofen pump, regular visits are required to refill the pump. In addition, a new pump must be surgically inserted every five years.

ORTHOPEDIC SURGERY

Orthopedic surgery involves clipping affected tendons or muscles to improve function by weakening the muscle. In most cases, SDR is recommended prior to orthopedic surgery because SDR can preserve muscle strength. Orthopedic surgery focuses on muscle shortening caused by spasticity with the goal of increasing muscle length to improve joint alignment and function, but it does not affect spasticity. SDR is different because it addresses one of the underlying reasons for muscle shortness and should be done prior to lengthening to reduce the likelihood of muscles shortening again.

What Is Selective Dorsal Rhizotomy (SDR)?

SDR is a surgery on the spine to sever the overactive nerves causing spasticity. The operation helps relieve lower-limb spasticity. In many cases, it also helps reduce pain and improve mobility.

In SDR, the surgeon opens a small section of the spine, finds the group of sensory nerve fibers causing the tensed muscles, and cuts the nerves causing the most tension. Patients should then be better able to control their muscles, since the nerves that function properly are left intact, sending the proper signals for tensing and relaxing back and forth from the brain to the limbs.

Only a handful of pediatric hospitals offer SDR. It is considered a safe and effective operation, but few surgeons are experienced in the technique. Neurosurgeons at Nationwide Children’s believe SDR is one of the most beneficial treatment options for spastic cerebral palsy. With SDR, the improvement in spasticity is permanent.

Who Is a Good Candidate for SDR?

Children may be good candidates for SDR if:

- They have some ability to walk (are ambulatory) — assisted or independently — but are limited by spasticity in the legs.
- They are not able to walk (are non-ambulatory) and have spasticity affecting all four limbs that makes daily care, such as dressing and diapering, difficult.

Most people who are good candidates for SDR surgery have spastic cerebral palsy. Children with brain or spinal cord injuries may also be good candidates for the surgery in some cases.

Benefiting Ambulatory and Non-ambulatory Patients



Improving Mobility for Patients Who Can Walk

- They may be able to walk assisted or independently.
- Spasticity in the legs hinders walking.
- SDR may substantially improve mobility and reduce pain.

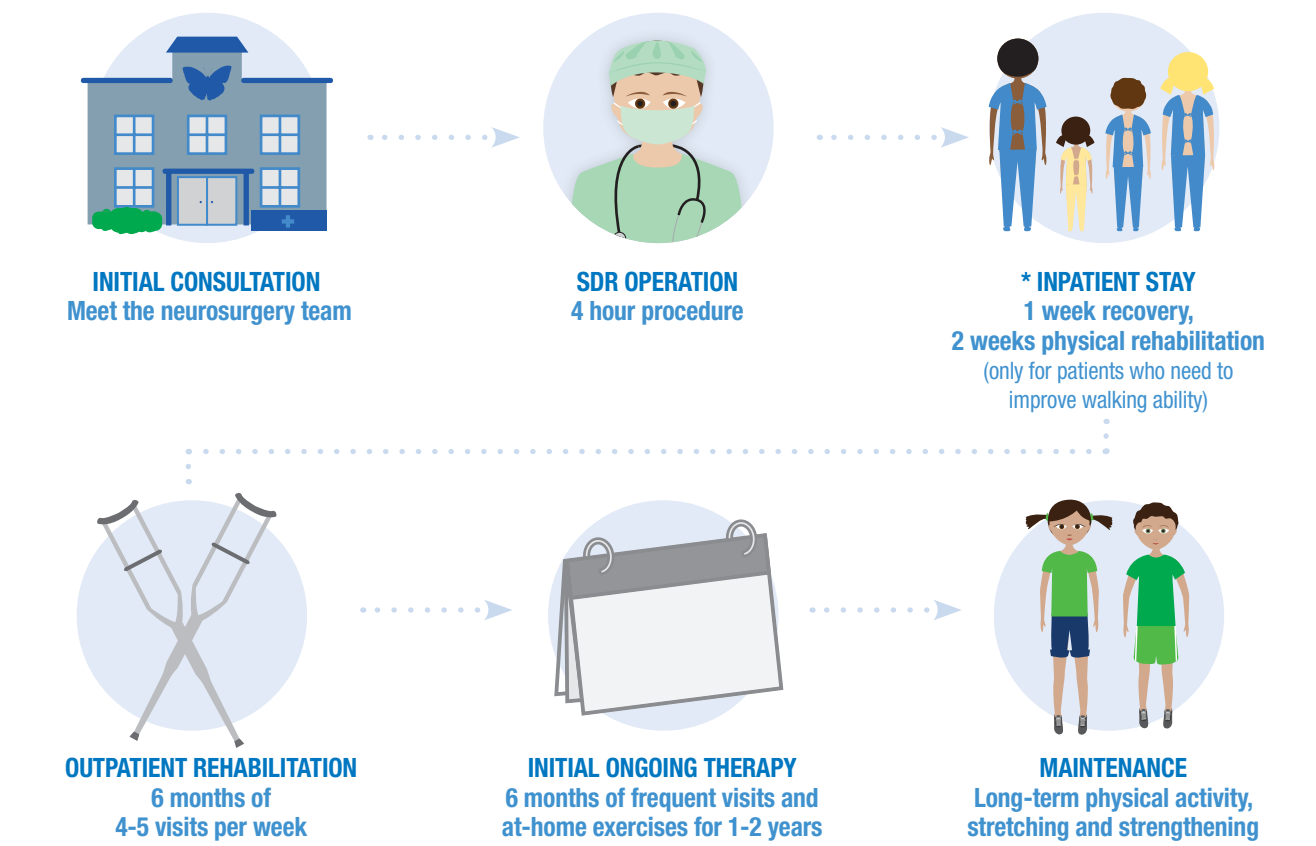


Improving Daily Life for Non-ambulatory Patients

- They are not able to walk.
- Spasticity affects all four limbs and hinders activities of daily living.
- SDR may substantially improve daily care, such as dressing and diapering and reduce pain.

Undergoing SDR: The Patient Journey

Children who may benefit from SDR will work with members from Nationwide Children's leading neurosurgery, physical therapy and rehabilitation programs to create a holistic plan for personalized care before, during and after the operation.

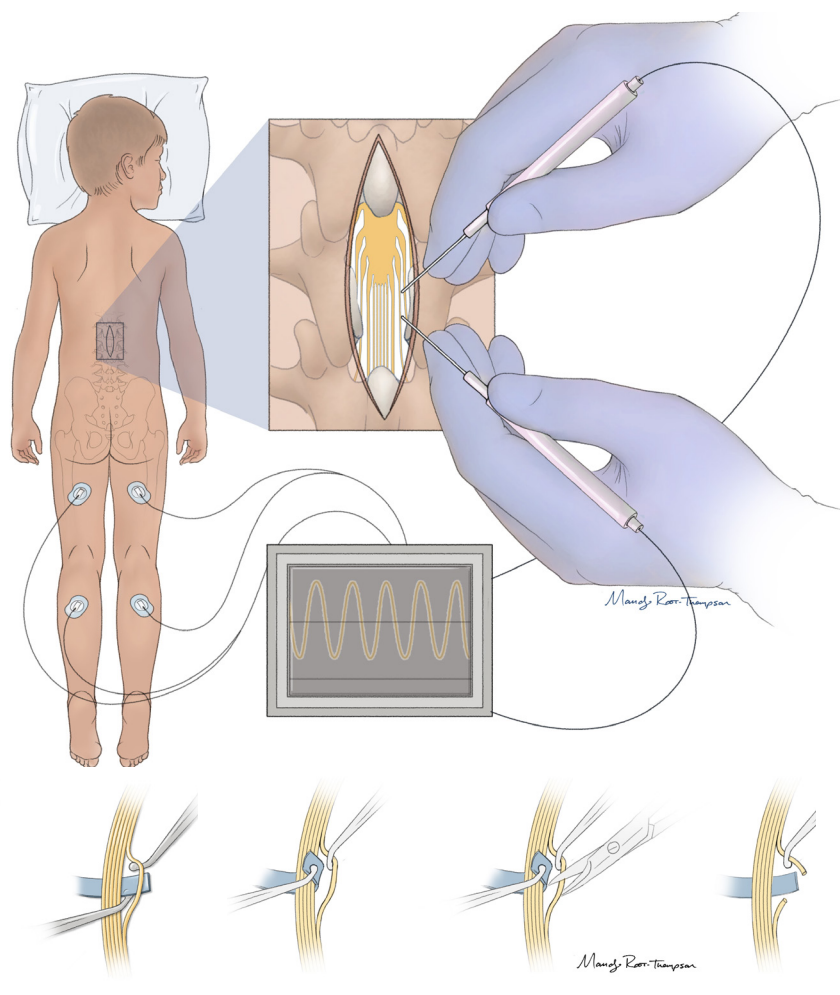


*\* Non-ambulatory patients do not require an inpatient rehab stay and will require less intensive physical therapy following the procedure.*



### Step by Step: The SDR Procedure

SDR is done in a single operation. At Nationwide Children's, the procedure takes about four hours. A surgery nurse will come out from time to time to give parents updates on their child's operation.



### During the Operation:

1. The patient will be put to sleep using anesthesia. They will be given antibiotics through an IV.
2. The surgeon makes a 1- to 2-inch cut along the lower backbone.
3. The surgeon creates a small "window" to the inside of the spine by removing two parts of a single vertebra:
  - The spinous processes (the bumpy part of the spine that you can feel under the skin)
  - The lamina (a flat part of the bone that covers the nerve fibers)
4. An ultrasound and an X-ray show the surgeon which nerve fibers can be cut (sensory nerves) and which need to stay so that the muscle can be moved and controlled (motor nerves). The surgeon separates the sensory nerves from the motor nerves using a small rubber pad.
5. The sensory nerves are tested in small bundles using electromyography (EMG). EMG shows the electric activity of the muscles so that the surgeon can see which bundles of nerves cause the spasticity.
6. Based on the EMG results, the surgeon cuts any severely spastic bundles. Healthy sensory nerve bundles and the child's motor nerve bundles are left intact.
7. The surgeon closes up the membrane that protects the nerves and puts a pain relief medication on the nerves.
8. To complete the procedure, the surgeon sews the tissue and muscle layers back together and then glues the skin shut.

### What to Expect: From the Hospital to Home

After the operation is complete, patients recover in the post-surgery room for about two hours before going to a room in the neuroscience unit. Parents get to speak with the surgery team about how the surgery went.

The skin glue on the surgical cut will peel off on its own as the skin heals. Nurses will care for the surgical wound while patients are at the hospital and will provide training on how to care for the wound once patients go home. Patients can expect a few months of weakness in the lower limbs as the body adjusts to the lack of spasticity.

Patients who are ambulatory (able to walk) and undergoing SDR to improve walking typically stay in the hospital for about three weeks. The first week is spent in the neuroscience unit, and the last two weeks will be in the rehabilitation unit.

Patients who are not ambulatory (unable to walk) and undergoing SDR to improve daily life typically stay in the hospital for three to five days. The following information (Inpatient Rehabilitation) focuses on improving walking abilities and does not apply to non-ambulatory patients.

### Inpatient Rehabilitation (ambulatory patients only)

A critical part of a selective dorsal rhizotomy is what happens after surgery. SDRs are most effective when they are followed by long-term physical therapy. This begins while patients are still in the hospital and is called inpatient rehabilitation.

**Inpatient rehabilitation** includes at least three hours per day (except weekends) of multidisciplinary therapy services including physical therapy, occupational therapy and therapeutic recreation. These are done to help improve muscle strength, control and coordination using exercises, games and assistive technologies. Each child's rehabilitation stay is tailored to his or her specific needs and generally lasts two to four weeks.

- **Physical therapy** will focus on improving balance, sitting, standing, walking and other gross motor skills, and muscle control.
- **Occupational therapy** will focus on improving balance, trunk control, and coordination to increase independence with activities of daily living, such as bathing and dressing.
- **Therapeutic recreation** will focus on improving balance, coordination and walking through the use of play and leisure activities to enhance health, functional abilities, independence and quality of life.

### Outpatient Physical Therapy

Before discharge from the hospital, information will be provided to your local therapy professionals to ensure they are familiar with surgical recovery and expected rehab progression.

Once patients return home, we typically recommend outpatient rehabilitation visits four to five times per week for the first six months for children who can walk independently with or without a device. Ongoing, frequent therapy beyond six months is often necessary for children who were using a walker prior to surgery. Therapy needs are patient specific. Non-ambulatory patients will have different outpatient therapy needs.

### When to Expect Improved Walking (ambulatory patients only)

Independent walkers and those who used crutches to walk before the operation often return to previous walking abilities within several weeks. Patients who required assistance before the operation may take much longer (a few months) to get back to their previous walking level. Improvements come with consistent physical therapy during and after that time period and may continue for years.

## What Are the Benefits of SDR?

SDR is the only surgery that can permanently reduce spasticity in cerebral palsy (CP). Nearly everyone who undergoes SDR experiences improved mobility, reduced pain, and/or relief of lower-limb muscle spasticity. Intense physical therapy after the operation is crucial for the greatest improvements in muscle flexibility and mobility. In all cases, spasticity in the legs is permanently reduced, if not fully eliminated.

Improvements in motor function are most obvious in the six months after SDR, but they often continue slowly and steadily for years after the operation.

Other benefits may include:

- Increased ability to walk and balance
- Better muscle control when sitting and standing
- Ability to perform new types of exercise and strength training (including a treadmill)
- Improvements in upper body muscle control
- Improved joint range of motion in lower extremities
- Improved ease of assisted lower body dressing and/or toileting

The surgery may also relieve or improve certain CP-related lower-limb deformities, such as hip subluxation, foot deformities and in-toeing. SDR at an early age may be most beneficial for minimizing the impact of deformities.

SDR also offers a way to treat spasticity without affecting muscle strength.

## What Are the Risks of SDR?

As with any surgery, SDR carries the risk of infection, bleeding, swelling, and a reaction to the anesthesia. Pain relief and antibiotics will be given to help avoid discomfort and infection after the surgery.

Because the operation involves the spinal cord, other possible (but highly unlikely) risks include:

- Spinal fluid leak (this normally goes away on its own, but in some cases, it may require another surgery to stop the leak)
- Bladder dysfunction
- Impotence
- Loss of feeling in the legs
- Unusual sensitivity in the skin of the feet or legs (this usually goes away within two to three weeks)
- Short-term loss of bladder control (for a few weeks only)
- Development of a spinal deformity

People with severe spasticity in the arms and legs may not achieve complete elimination of spasticity after SDR. Spasticity is also more likely to return in these cases even if the surgery initially improved it.

Even in people who do have a significant improvement in spasticity, orthopedic surgery may eventually be needed for relief of some very tight or shortened tendons or muscles that don't get better with stretching therapy, night splints and casting.

## The SDR Approach and Experience at Nationwide Children's



Nationwide Children's is one of the few hospitals in the country offering this specialized operation for children with spasticity. For such rare procedures, surgical expertise is essential.

**Jeffrey Leonard, MD**, chief of Neurosurgery at Nationwide Children's, has significant experience performing SDR procedures. Dr. Leonard has created a comprehensive program since coming to Nationwide Children's from Washington University and St. Louis Children's Hospital. Dr. Leonard is also the neurosurgical leader for the Spasticity Network.

Dr. Leonard and his team evaluate patients with spasticity during an initial consultation to decide if SDR may be the right option for treatment. Evaluation may include diagnostic assessments, imaging, gait analysis, medical history and more.

## Our Surgical Technique

At Nationwide Children's, we take a targeted approach to SDR by operating on just one vertebra instead of seven — the number historically used in this procedure. This method may result in:

- Less pain and muscle weakness after the surgery
- Greater hip mobility
- Earlier return to physical therapy
- Lower risk for eventual spinal deformity

Families coming to Nationwide Children's for SDR can rest easy knowing that they are in the hands of an expert surgeon at one of the nation's leading hospitals for both neurosurgery and physical rehabilitation.

In addition to this surgical and physical therapy expertise, Nationwide Children's is now home to a revolutionary resource for patients with gait and mobility limitations. The Honda Center for Gait Analysis and Mobility Enhancement (GAME) offers advanced gait analysis and opportunities for additional SDR and spasticity-related physical rehabilitation and research.

By uniting our resources, facilities and professional expertise, we offer a cohesive and comprehensive approach to managing spasticity and SDR.

## Optimizing the Patient and Family Experience

At Nationwide Children's, patient quality of life is paramount. Our team wants to make sure that each patient with spasticity receives the most appropriate, advanced and personalized care plan possible so that each child can reach his or her full potential.

If you are considering a consultation for SDR or spastic cerebral palsy management, please feel free to use the Parent Visit Worksheet provided. Our program is open to new patients and welcomes new referrals and consultations. To speak with a member of our team, call (614) 722-2014, or visit [NationwideChildrens.org/SDR](https://www.nationwidechildrens.org/SDR) and fill out the Speak With Our Team form.





## Questions to Ask Your Child's Doctor About SDR

No matter where you go for care, you can use these questions to learn more about whether SDR and the hospital care team are a good fit for your family.

- Is my child a good candidate for SDR? Why or why not?
- What types of improvements are we likely to see in my child's motor skills?
- How likely is it that improvements would be permanent for my child?
- How experienced are you in this procedure?
- Do you operate on more than one vertebra? If so, what does that mean for my child's recovery?
- What are the alternatives to this surgery?
- What are the pros and cons of waiting until my child is older to do the operation?
- What will the physical therapy routine be like?
- Are there any patient families who would be willing to talk about their experience with us?
- What treatments do you expect my child will need when they are older to manage spasticity or lower limb deformities?

## Recent Publications

Makoshi Z, Raskin J, Bollo R, Rocque B, Zickmund S, Galyean P, Perry G, Browd S, Gross P, Bjornson K, **Leonard J**. A Mixed Methods Study of Practice Variation in Selective Dorsal Rhizotomy: A Study by the Cerebral Palsy Research Network. *Pediatr Neurol*. 2023;149:159-166.

**Blatt K, Lewis J**, Bican R, **Leonard J**. Selective Dorsal Rhizotomy: Patient Demographics and Postoperative Physical Therapy. *Pediatr Neurol*. 2023;147:56-62.

Hatef J, Smith LGE, **Veneziano GC, Martin DP**, Bhalla T, **Leonard JR**. Postoperative Pain Protocol in Children after Selective Dorsal Rhizotomy. *Pediatr Neurosurg*. 2020;55(4):181-187.

## Referrals and Consultations

Online: [NationwideChildrens.org/SDR](https://NationwideChildrens.org/SDR)

Phone: (614) 722-2014 | Fax: (614) 722-2041

Physician Direct Connect Line for 24-hour urgent physician consultations:  
(614) 355-0221 or (877) 355-0221



**NATIONWIDE CHILDREN'S®**  
*When your child needs a hospital, everything matters.*