

Spinal Cord Injury and Gait Training



For more information, contact your nearest SCI Model System. For a list of SCI Model Systems, visit: <http://www.msktc.org/scifindms.asp>

This publication was produced by the SCI Model Systems in collaboration with the University of Washington Model Systems Knowledge Translation Center (UW MSKTC) with funding from the National Institute on Disability and Rehabilitation Research in the U.S. Department of Education, grant no. H133A060070.

Follow us!



Visit <http://scimodelsystems.org/social> to sign up.

People with an “incomplete” SCI have more potential to regain walking than those with a “complete” SCI, but people with both types of SCI may have gait training included in their therapy plans.

Gait training is practicing walking (also called ambulation) with assistive devices (see description on page 2), braces and other types of support as needed.

The following categories are used by health professionals to describe the kind of walking you are able to do.

- **Community:** You are able to walk at home and in the community.
- **Household:** You can walk within the home and use a wheelchair as the primary way to get around in the community.
- **Exercise:** You use a wheelchair in the community and at home, and you walk with assistance once or twice a day for exercise.
- **Non-ambulatory:** You only use a wheelchair for mobility. You may also walk while doing gait training with the therapist in the therapy gym only.

Why might gait training be needed?

A spinal cord injury damages nerve cells and their connections. This damage can prevent movement signals from the brain to the muscles which can cause weakness or paralysis. It can also disrupt the signals that do reach the muscles, making the muscles “jump” on their own or be very stiff and difficult to move (spasticity). Therefore, a SCI can create weakness, paralysis and/or spasticity in the feet, legs, hips, and trunk, as well as in the hands and arms.

The injury can also damage and disrupt nerve signals for sensation (feeling) so that parts of the body are without sensation or have abnormal sensations, such as burning or tingling.

Each of these problems can lead to difficulty walking and increase the risk of falling, or result in the inability to regain walking.

The aims of gait training are to:

- Improve the ability to walk for people with SCI who can regain walking.
- Improve fitness for all people with SCI, including people who are non-ambulatory.

Will gait training be effective for you?

Each individual makes progress in therapy at his/her own pace. Some people may learn to walk well in a few months; others may take years to be able to walk just for exercise. Still others may never undergo gait training.

It is important for all people with SCI to remain active and healthy. This can include eating well, pushing your wheelchair, working out with adaptive machines in your local gym, team sports, or any other kind of physical and social activity you can do safely.

The ability to walk after a spinal cord injury depends on many factors including your:

- Level of injury.
- Severity of injury.
- Time since injury.
- Age.
- Level of fitness.
- Other injuries.
- Level of sensation.
- Other related problems such as spasticity and joint problems (contractures).
- Level of pain.

Therefore, it is difficult to predict if a person with SCI will regain walking abilities. Most people with SCI who can walk on a regular basis continue to need devices or braces, or both; and most have a wheelchair for long distances.

How to determine if gait training is right for you

A physical therapist (PT) or other clinician will determine if gait training is right for you by using a variety of tests.

- He/she will test your strength, sensation, ability to stand up, balance while standing, spasticity or stiffness, and range of motion at your hips, knees, ankles, and trunk. If you are able to take some steps, the clinician will watch you walk to look for safety issues.
- The clinician may also provide assistive devices and/or braces to give you better balance, protect your joints, and ensure your safety as you walk.
- He/she may then test your walking speed, endurance, and balance with these devices and braces to keep track of your therapy progress.

Gait training can require a lot of work and be a long process, so it is important for your PT or other clinician to tell you what you can expect. Some people with SCI work on balance and other “pre-gait” activities many times a week for many months before they start actual gait training (involving walking). Pre-gait activities include stretching, strengthening, weight bearing, balance training, and coordination training to get ready for walking.

Gait training may not be appropriate for you if:

- You are too weak to support your body weight over ground.
- Your blood pressure is unstable.
- You have fractures or risks for fractures.
- You have a high risk falling and hurting yourself.
- You are unlikely to become independent with walking.

The physician and therapist will want to make sure you are safe before starting gait training and during the training. It would be far worse to fall and hurt yourself, setting yourself back, than to continue safely with therapy. Over time your condition may change, affecting whether gait training is right for you.

Gait training treatment options

Early Gait Training – Beginner level

If gait training is right for you, it is best to be upright and moving as soon as possible.

You may take your first steps after the SCI using a variety of equipment including parallel bars, a walker and braces, a pool, or a body-weight support device.

A body-weight support device lifts part of your weight through a harness you wear as you try to take some steps.

Some of these devices roll on the ground and some are placed over a treadmill. Your therapist, a therapy team, or a robotic-device may help with your balance and stepping movements.

Later Gait Training – More advanced level

Depending on your SCI, your therapist may begin to work with you on the ground without a body-weight support device or parallel bars. You may

also be given assistive devices and/or braces to improve your balance and help you walk safely.

The specific device you need will depend on your strength and balance. It is helpful to experiment with different assistive devices and braces to find what is right for you.

Assistive devices may include:

- Special walkers that have safety straps at your hips and trunk.
- A standard walker with no wheels on the legs.
- A rolling walker (walker with 2 wheels on front legs), if your balance is a little better.
- A rolling walker with forearm platforms, if you have weak arms and hands.
- A rollator walker (walker with 4 wheels and a basket), if you have good enough strength to walk in the community, but still need help with balance.
- One or two forearm (or “Loftstrand”) crutches, if you have even better strength to walk in the community, but need less help with balance and have a weak grip.
- One or two quad canes with four tips at the bottom, if you have good strength to walk in the community, need even less help with balance, and have at least a fair grip.
- One or two straight canes with a single tip at the bottom, if you only need a little help with your balance to walk in the community and have a good grip.

If you are able to use crutches and canes, you will likely start with two, using one in each hand.

Sometimes you will train with a crutch or cane in only one hand to be able to use your other hand to carry things, open doors, etc. However, you should be careful when using only one crutch or cane. Many people who use a device in only one hand tend to lean on it too much and develop a limp to that side. Using a device in each hand helps to keep your posture straight and your steps even.

Braces

A brace (also called an orthosis), can have many benefits:

- Protecting weak joints, preventing knee hyper-extension (backward stretching of the knee), and preventing contracture (loss of range of joint movement) by keeping your joints in the correct alignment as you put weight on them during walking.
- Reducing the risk of falling by helping to keep your knee straight as you put weight on your leg and to keep your toes up off the ground as you take a step.
- Increasing your walking speed and how long you are able to walk.

Types of braces:

- Ankle-foot-orthosis (AFO) - worn on the lower leg to support the ankle and foot.
- Knee-ankle-foot-orthosis (KAFO) – worn up to the thigh to support the knee, ankle, and foot.
- Hip-knee-ankle-foot-orthosis (HKAFO) – worn up to the hip to support the entire leg.
- Floor reaction orthosis– worn over the knee and lower leg for people with a knee that buckles.
- Supra-malleolar orthosis (SMO) – worn just around the ankle and part of the foot for people who tend to roll their ankles.

Braces may be made of plastic and metal, just plastic, or carbon fiber. They may be “off-the-shelf” pre-made braces, or they may be custom made by an orthotist (health care provider who specializes in braces) to fit you. Some newer ankle-foot-orthosis designs, such as the “lateral strut” braces, try to fit more people with a light-weight, strong, and more open pre-made shape.

Get evaluated by your therapist or orthotist to determine the best brace for you, especially if you cannot feel where the brace will go.

It is also important to visit your therapist or orthotist as your walking improves to ensure you

are using the correct devices and braces over time.

Always be sure you check your skin before you put the brace on and after you take it off, looking for reddened areas on your skin or open wounds. If the brace has caused a pressure sore, do not wear it again until your therapist or orthotist can modify it for you.

Functional electrical stimulation

Another option to use with or instead of braces is electrical stimulation. Functional electrical stimulation (FES) (also called neuroprosthesis) stimulates certain muscles in the legs to do the same job as a brace during walking. For example, a cuff with electrodes (material that transfers an electric current) may be placed around the lower leg that stimulates the muscle that picks up the foot as you take a step. If it works well for you, this may be used in place of a plastic AFO.

The electrodes for electrical stimulation may also be on separate small pads (without the cuff) on the skin or be surgically implanted.

Body-weight support device

If you are eventually able to walk with assistive devices or braces, you may still continue gait training on a body-weight support device to help increase your speed and improve your balance and the timing, coordination, and symmetry of your steps. This is performed without using walking devices or braces. You will receive verbal instructions and manual assistance from your therapist and team.

All levels of gait training activities can be practiced safely in the harness of the body-weight support device, because you cannot fall.

Transferring what you have practiced in the harness over a treadmill to walking on the ground is very important. Assistive devices and braces may still be required to protect your joints and prevent you from falling and possibly breaking a bone when training on the ground.

Continued gait training with your therapist will hopefully improve your balance and strength so that you can rely less on devices or braces.

Safety

Gait training must only be done in a safe environment. If you fall, you could break a bone or hit your head which would delay your recovery for a long time. Preventing falls is a top priority during both gait training and walking in the community.

If you experience falls while walking with or without assistive devices, be sure to tell your health professional as you may need different walking supports and/or more training.

Falling can be very dangerous for people with SCI, because they often have fragile bones due to lack of physical movement, so falling can easily cause broken bones.

Using gait training for exercise only

Individuals with complete SCIs, with significant weakness, or with spasticity typically use a wheelchair in their daily lives.

Gait training for exercise only may be recommended by your doctor because it can help with fitness, spasticity and blood pressure. Other reasons for using gait training for exercise only, instead of for walking in the community include:

- Walking with assistive devices and KAFO multiple braces can be very difficult and slow.
- It takes a lot of arm strength and energy for people with completely paralyzed legs or with very stiff legs to walk with assistive devices and braces, and they get tired very quickly.
- People who try to walk this way for a long time must beware of shoulder, elbow, and wrist injuries, because they are essentially now bearing most or all of their body weight through their arms, instead of their legs.

What does the research show?

- People with incomplete SCIs have greater potential than those with complete SCIs to regain function and walking.
- People with the “incomplete” injuries of Brown-Séquard Syndrome (left or right half of the spinal cord is injured) or Central Cord Syndrome (the arms are more affected than the legs) have the greatest potential to regain walking.

- People with SCI who have more accurate sensation also have a better chance of walking.
- People with a complete injury level below T11 have greater potential to walk in the community while using devices and braces than those with an injury of T11 or higher.
- A study (van Hedel et al, 2009) found that walking speed can help predict your level of independence at home and in the community.
 - The minimal walking speed of a household walker was found to be 0.15 meters per second, or 0.34 miles per hour.
 - The walking speed to change from being a household walker to being a limited community walker using a walking device was found to be 0.44 meters per second, or just under 1.0 mile per hour.
 - Those who walked full-time in the community without a walking device walked a minimum speed of 0.70 meters per second, or 1.57 miles per hour.
 - Your therapist will work on improving speed as well as quality of movement during gait training, while making recommendations to prevent a fall and bone fracture.
- A study (Winchester et al, 2009) found that after a locomotor training program, faster walking speeds were associated with an earlier time since injury, mild (not severe) spasticity, and the recovery of bladder and bowel control.
- A study (Harkema et al, 2011) found that people with incomplete SCIs who have movement in their legs can make improvements in balance and walking speed and endurance if enrolled in an intensive locomotor training program.
 - All groups of participants, whether <1 year post-SCI, 1-3 years post-SCI, or >3 years post-SCI made significant improvements in these area.
 - However, they also found that those with more time since the injury had less improvement than those with more recent injuries.
- A study (Riggins et al, 2011) found that at the end of one year post-injury, people who were discharged from therapy trying to walk, but returned to using a wheelchair had greater pain and more depression. This study shows:
 - If you leave therapy walking in the community, but weakly and/or poorly, it is important to be fully independent in your wheelchair, in case you need to use it again for daily functioning.
 - If you have more strength in your legs, more family/friend support, and a better socioeconomic status, you may have a better chance of walking one year after injury, whether or not you left therapy walking or using a wheelchair.

ASIA Impairment Scale

Looking at severity of injury as a factor, the following numbers show the percentage of people in a study (Morganti et al., 2005) who walked with some kind of assistive device and/or braces but no physical assistance from another person, at the time of discharge from inpatient rehabilitation. The ASIA Impairment Scale (AIS) classification level was made when patients were admitted to the hospital.

Proportion of people with SCI who walked at inpatient discharge with devices/braces and without physical assistance:

- ASIA A (motor and sensory complete): 6.4%
- ASIA B (motor complete, sensory incomplete): 23.5%
- ASIA C (motor and sensory incomplete, generally weaker legs): 51.4%
- ASIA D (motor and sensory incomplete, generally stronger legs): 88.9%

These numbers are to be read with caution, because each person's injury, circumstances, and availability to resources, such as equipment and family support, are very different. Also, those classified as ASIA A who walked with devices and braces likely had levels of injury around T11 and below.

Principles to effective gait training

For those who are able to participate in gait training, research has shown that your brain and spinal cord will better learn to walk if a few principles are followed during therapy (van Hedel and Dietz, 2010):

- You must practice walking (not standing or cycling) with some weight bearing.
- Practice as much as possible, by taking as many steps as you can during the session in the clinic (and outside the clinic ONLY if your therapist says it is OK).
- Participate in the training by working hard with the equipment and not being passive, such as relaxing in a robotic device.

Resources

Atrice MB, Morrison SA, McDowell SL, Ackerman PM, Foy TA. Traumatic spinal cord injury. In: Umphred DA. Neurological Rehabilitation. 5th ed. St. Louis, MO: Mosby; 2006: 605-657.

Field-Foté E. Spinal Cord Injury Rehabilitation (Contemporary Perspectives in Rehabilitation). Philadelphia, PA: F A Davis Co; 2009.

Sisto SA, Druin E, MachtSliwinski MM. Spinal Cord Injuries: Management and Rehabilitation. St. Louis, MO: Mosby; 2008.

M Selzer, B Dobkin. Spinal Cord Injury: A Guide for Patients and Families (American Academy of Neurology). New York, NY: Demos Health; 2008.

References

Gittler MS, McKinley WO, Stiens SA, Groah SL, Kirshblum SC. Spinal cord injury medicine. 3. Rehabilitation outcomes. Arch Phys Med Rehabil. 2002;83,Suppl 1: S65-71.

vanHedel HJ, Dietz V. Rehabilitation of locomotion after spinal cord injury. Restor Neurol Neurosci. 2010;28:123-134.

Winchester P, Smith P, Foreman N, Mosby JM, Pacheco F, Querry R, Tansey K. A prediction model for determining over ground walking speed after locomotor training in persons with motor incomplete spinal cord injury. J Spinal Cord Med. 2009;32:63-71.

Morganti B, Scivoletto G, Ditunno P, Ditunno JF, Molinari M. Walking index for spinal cord injury (WISCI): criterion validation. Spinal Cord. 2005;43:27-33.

vanHedel HJ, EMSCI Study Group. Gait speed in relation to categories of functional ambulation after spinal cord injury. Neurorehabil Neural Repair. 2009;23:343-350.

Harkema SJ, Schmidt-Read M, Lorenz D, Edgerton VR, Behrman AL. Balance and ambulation improvements in individuals with chronic incomplete spinal cord injury using locomotor training-based rehabilitation. Arch Phys Med Rehabil. 2011; Jul 19. Epub ahead of print.

Riggins MS, Kankipati P, Oyster ML, Cooper RA, Boninger ML. The relationship between quality of life and change in mobility 1 year postinjury in individuals with spinal cord injury. Arch Phys Med Rehabil. 2011;92:1027-33.

Source

Our health information content is based on research evidence whenever available and represents the consensus of expert opinion of the SCI Model System directors.

Authorship

SCI & Gait Training was developed by Leslie Van-Hiel, BME, MSPT, CCRC., in collaboration with the University of Washington Model Systems Knowledge Translation Center.

Disclaimer

This information is not meant to replace the advice from a medical professional. You should consult your health care provider regarding specific medical concerns or treatment.