



Penn Medicine

TREATMENT OF SPASTIC FOOT DEFORMITIES

PENN NEURO-ORTHOPAEDICS SERVICE



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OVERVIEW

Severe loss of movement is often the result of neurological disorders, such as stroke or brain injury. As a result, ordinary daily activities such as walking, eating and dressing can be difficult and sometimes impossible to accomplish.

The Penn Neuro-Orthopaedics Service assists patients with orthopaedic problems caused by certain neurologic disorders. Our team successfully treats a wide range of problems affecting the limbs including foot deformities and walking problems due to abnormal postures of the foot.

This booklet focuses on the treatment of spastic foot deformities under the supervision of Keith Baldwin, MD, MSPT, MPH.



► Pre-operative right foot.



► Post-operative position of the right foot.

TREATMENT OF SPASTIC FOOT DEFORMITIES

The Common Problem

An injury to the brain or spinal cord often affects the brain's control of the muscles in the arms and legs. A condition called spasticity occurs when the muscles in the leg turn on too early during walking or overreact to a stretching force. Another condition, called increased tone, occurs when a muscle has difficulty relaxing.

The foot most commonly develops a deformity called equinovarus or an adult club foot. This refers to the foot being in a toe down position (equinus) and also tilted inward (varus). The toes usually curl painfully in the shoe. The big toe may pull into an up position when the leg swings during walking, a condition commonly called a "Hitch Hiker Toe." It is difficult to walk with the foot in such an awkward position and painful to stand on the twisted foot. The abnormal position of the foot causes poor balance and aggravates other spastic muscles both in the leg and in the arm.

► An equinovarus foot is common after brain injury or stroke. It is caused by abnormal activity in several muscles.



If the abnormal muscle pull is not strong, then a short leg brace, called an ankle foot orthosis (AFO), can control the position of the foot. Frequently, the muscle pull is very strong. In this situation a brace is not sufficient to keep the foot in a normal position.

Treatment for muscle spasticity with oral medications causes drowsiness and is not effective. Other treatments, such as phenol nerve blocks and botulinum toxin (Botox®) muscle injections, provide only temporary muscle relaxation. Generally a permanent solution, such as orthopaedic surgery, is needed. This surgery is helpful in re-balancing the muscle pull and straightening the foot. The surgery can be done as early as six months after the onset of the foot deformity and is also successful when performed many years later.

Several muscles working in combination cause the foot deformities. These include the calf and toe flexor muscles pulling the foot downward. The foot is twisted inward by the pull of the tibialis anterior muscle and the extensor muscle of the big toe muscle, located on the front of the leg. Often the posterior tibialis muscle, located behind the ankle, also adds to the inward turn of the foot.

Gait Study

If the diagnosis is in question, it can be helpful to perform a gait study. The test tells the doctors exactly how each muscle is behaving when a person is walking and gives an indication of the strength of the muscle pull. Information about walking speed and step size is also recorded during the test. This information is used to decide what combination of tendon transfers or lengthenings will give the best correction of the foot deformity.

TYPES OF SURGICAL PROCEDURES

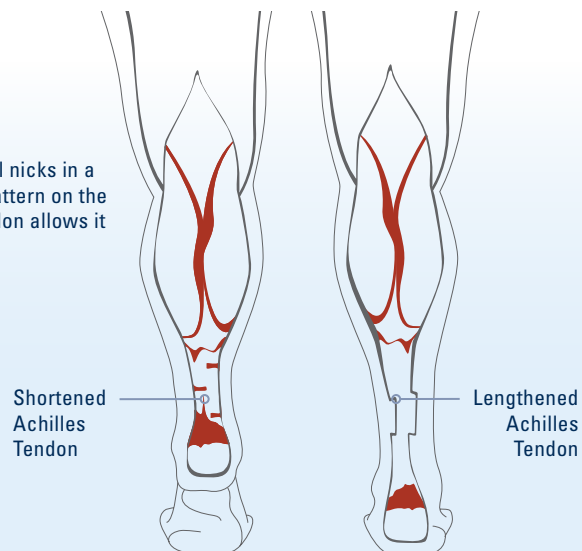
There are several surgical procedures used to correct these deformities. Most commonly, a combination of tendon lengthening and transfer is performed.

Achilles Tendon Lengthening

The toe down or equinus deformity of the foot is corrected by lengthening the calf muscles or Achilles tendon (the heel cord). A tendon is the structure or leader that connects a muscle to the bone. Making three small cuts in the tendon through small nicks in the skin lengthens the Achilles tendon. This allows the tendon fibers to stretch and brings the foot to a flat position on the floor.

When the foot deformity is less severe, the calf muscles are lengthened in the calf. This saves more strength in the leg. Dr Baldwin may decide to perform an Achilles lengthening or a gastrocnemius recession depending on what the pre-operative examination under anesthesia shows.

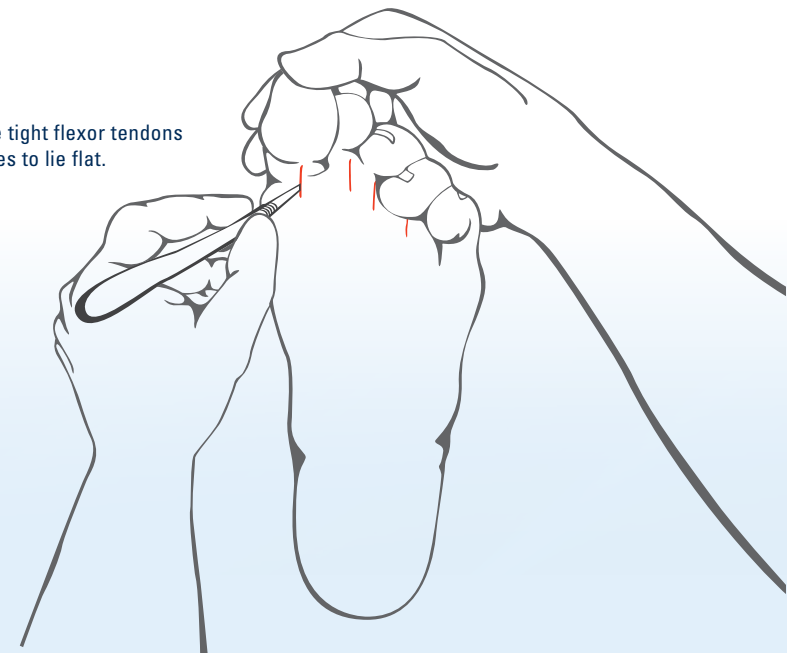
- ▶ Making small nicks in a staggered pattern on the Achilles tendon allows it to lengthen.



Toe Flexor Releases

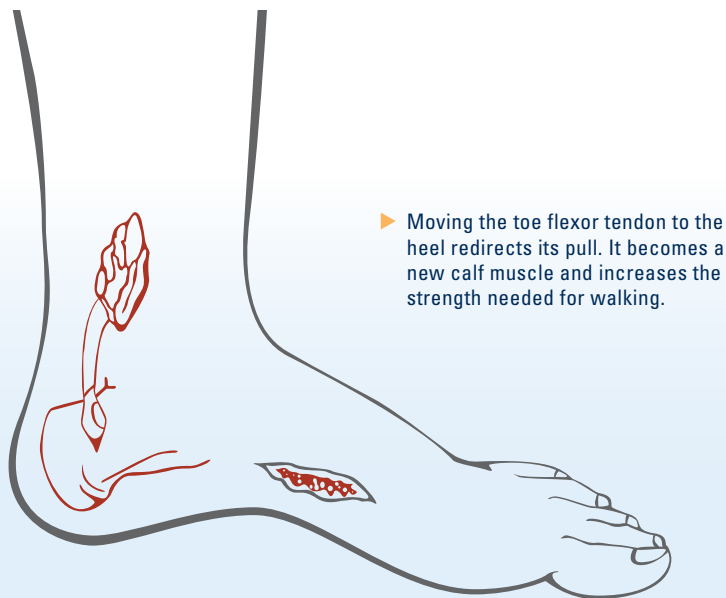
There are two sets of toe flexor muscles: the long muscles and the short muscles. The short toe muscles are in the arch of the foot. The long toe flexor muscles are in the calf and attach to the toes by long tendons that travel behind the ankle and through the foot. The long toe flexor tendons pull the foot downward into equinus and curl the toes. The short toe flexor muscles also curl the toes. In most feet, spasticity in both sets of muscles causes severe toe curling that is very painful when standing. To correct the toe curling deformity, both sets of tendons must be released. The tendons of each toe are released through a very small incision at the base of each toe on the undersurface of the foot. Toe flexor recessions may be performed if the deformity of the toes is dynamic, while hammertoe corrections may be performed if the joints are contracted.

- ▶ Releasing the tight flexor tendons allows the toes to lie flat.



Toe Flexor Transfer

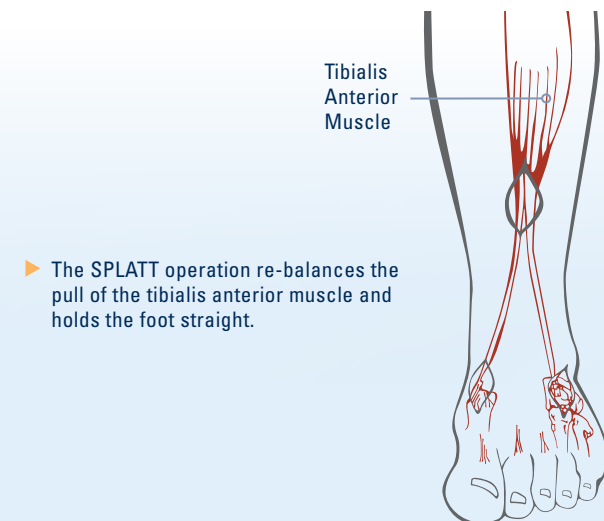
The calf muscles are weak because of the spasticity. The weakness is made worse by the inability to walk normally and exercise as before the injury to the brain or spinal cord. Normal walking requires strong calf muscles. In order to improve the strength of the weak calf, one of the long toe flexor tendons is transferred to the heel. Since the long toe flexor muscle resides in the calf, it is very easy to re-route its tendon into a small tunnel in the heel bone. This converts it to a calf muscle and significantly strengthens the leg. When this transfer is done, it is less likely that a person will need to use a brace for walking after surgery.



Split Anterior Tibialis Tendon Transfer (SPLATT)

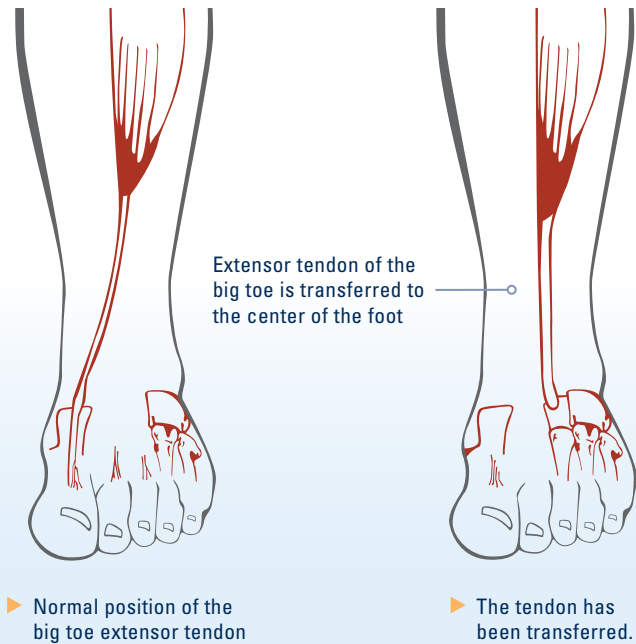
The inward twisting of the foot is commonly caused by overactivity in the tibialis anterior muscle. To re-balance the muscle pull, the tibialis anterior tendon is first split into two equal halves. One half of the tendon is moved to the outer side of the foot while the other half is left attached to the inner side of the foot. Now the muscle pulls equally on both sides of the foot. This is called a SPLATT operation. SPLATT is an abbreviation for this transfer.

Three small incisions are needed for the SPLATT transfer. The tibialis anterior muscle belly is located on the front of the leg. The tendon of the muscle attaches to the inner aspect of the foot. One-half of this tendon is surgically detached while the other half of the tendon is left in place. The detached half of the tendon is pulled upward in the leg under the skin splitting it into two portions. By pulling the tendon upward to the second incision the tendon now takes on a V-shape. The tendon is then passed under the skin to the third incision on the outside of the foot. This tendon is attached to a bone on the outside of the foot through a small tunnel. The tibialis anterior muscle now pulls evenly on both the inside and outside of the foot.



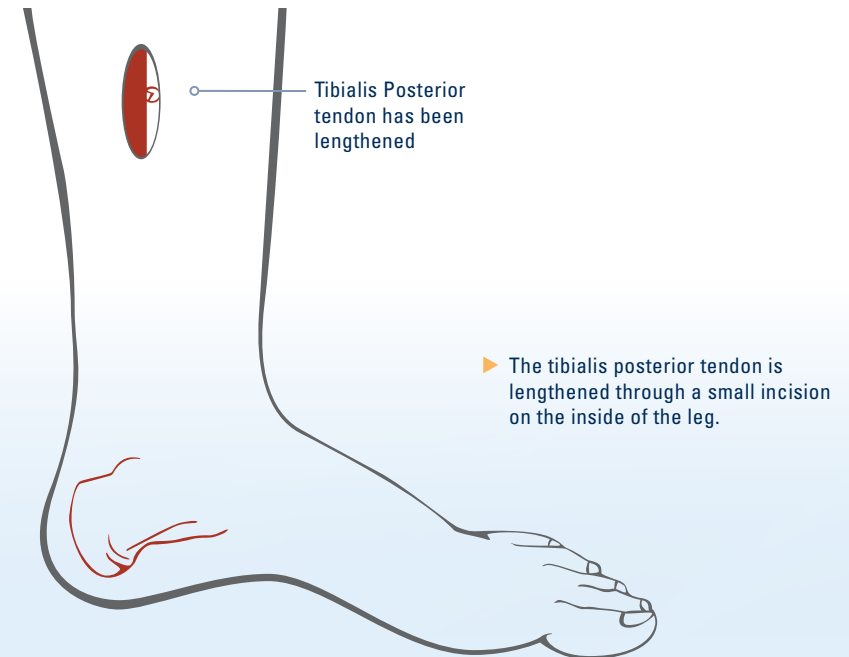
The Extensor Tendon of the Big Toe (EHL)

If the extensor muscle of the big toe is spastic, it causes a hitchhiker toe deformity in which the big toe points upward. This also causes the foot to turn inward into a varus position. The big toe often hits the top of the shoe causing a callus or sore. Transfer of the big toe extensor muscle to the center of the top of the foot will correct this problem. This enables the extensor muscle to help pull the entire foot upward and prevent the toes from dragging on the floor. Transfer of the big toe extensor muscle requires only a small incision of the top of the foot.



Lengthening of the Tibialis Posterior Tendon

If the tibialis posterior muscle has abnormal activity, it also pulls the foot inward. This pull is most commonly seen with the heel turning inward. This muscle can easily be lengthened at the point where the muscle and tendon connect, located on the inner aspect of the leg. The tibialis posterior muscle lies directly next to the long toe flexor muscles. If it needs to be lengthened, it is done through the same incision as the toe flexor transfer.



CARE AFTER SURGERY

After surgery, it is important to hold the foot in a natural position until all of the tendons have healed. It takes a total of three months for tendons to heal to the bone in their new position.

First, a short-leg walking cast is applied in the operating room, allowing the person to walk on the foot with full weight while in this cast. It is important not to allow the cast to get wet. Heavy plastic cast covers are available from medical supply stores. These provide a waterproof seal and will allow a person to shower while wearing the cast. Plastic garbage bags should not be used to protect the cast from water because they are made of thin plastic and will leak. If the cast gets wet, it must be changed promptly since wet bandages can cause skin sores and infection.

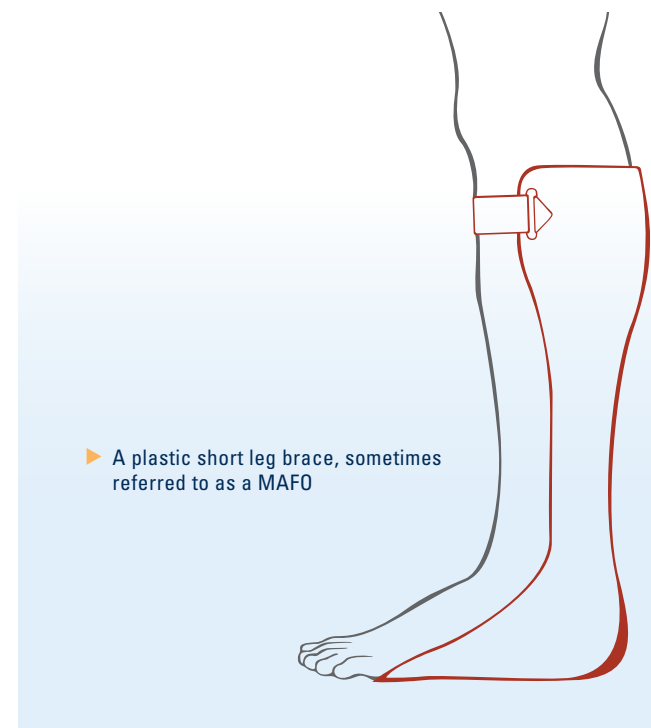
Approximately two weeks after surgery, the cast is removed, the bandages are changed and the healing of the incisions is checked. A new short leg walking cast is applied.

Six weeks after surgery, the foot is then held in a short-leg brace. The brace is used to hold the foot in a neutral position for an additional six weeks. Commonly, a short plastic brace is used which fits inside of the shoe. It is necessary to have a shoe that is at least one size larger than the person's normal shoe so that the brace can fit comfortably. The brace is worn continuously, even while sleeping, for another six weeks to allow further healing and strengthening of the tendons.

Swelling in the foot is very common after surgery, but it is a temporary problem. Frequent elevation of the foot above the heart best treats the swelling. When wearing the brace, an elastic support stocking is also very useful.

Three months after surgery, it is possible to begin walking without the brace. The brace must be discontinued slowly to allow the muscles to become stronger. It is important to walk and exercise the foot regularly to regain the strength in the muscles.

At first, the patient is allowed to walk without a brace for ten minutes, three or four times a day. As the leg gets stronger the amount of time without the brace is slowly increased. Approximately 70% of people who have these operations are eventually able to walk comfortably and safely without a brace. Those who still need a brace will wear a lightweight and generally flexible plastic brace and are able to walk better and have improved balance.



NOTES

ABOUT THE PENN NEURO-ORTHOPAEDICS SERVICE

The Penn Neuro-Othopaedics Service, part of the Penn Comprehensive Neuroscience Center and Penn Orthopaedics, offers the latest advances in diagnosis and treatment to patients whose arms or legs are impaired by brain injury, stroke, central nervous disorders or orthopaedic conditions. We focus on recovering lost function, regaining mobility and improving performance in persons with permanent disability or chronic neurologic disease.

Our service is appropriate for patients with orthopaedic problems caused by brain injury, cerebral palsy, Charcot-Marie Tooth disease, multiple sclerosis, polio, spinal cord injury and stroke.

In addition to treating foot deformities and walking problems related to the foot, we successfully treat clenched-fist and thumb-in-palm deformity, flexed elbow deformity, heterotopic bone growth, hip and knee contractures, scissoring gait and stiff shoulder.

Information and Appointments

For more information or to schedule an appointment, call **800.789.PENN (7366)** or visit **PennMedicine.org**.

► Location



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