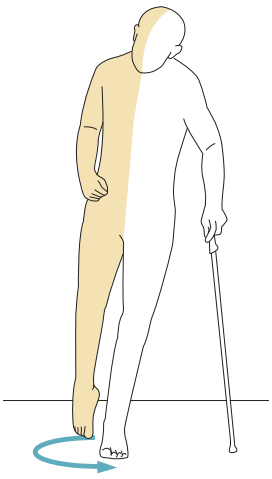
Functional Electrical stimulation to aid walking after stroke

Drop foot is one of the most common mobility problems following stroke. Drop foot (also dropped foot or foot drop) is the inability to lift the foot and toes properly when walking. It can lead to trips and falls, and a loss of confidence when walking. Functional Electrical Stimulation (FES) uses small electrical impulses to assist the muscles to lift the foot. It is clinically proven to improve walking speed, and reduce the effort of walking.

Clinical problem

DROP FOOT occurs when the muscles are not strong enough to lift the foot and toes. It can also occur if the foot lift is hampered by tight or overactive calf muscles due to spasticity. Weakness relating to drop foot can also cause the person to hit the ground on the outside of the foot, which may increase the risk of ankle injuries. Sufferers often compensate by swinging their leg outwards, or hitching their hip during walking. In all cases drop foot can lead to trips and falls, and slow inefficient walking. The individual often loses confidence, especially when walking outside. Drop foot can therefore have a negative impact on everyday activities such as household tasks, social activities, and hobbies.



Treatment options

The initial treatment for drop foot is usually physiotherapy. This includes exercises and, gait training. However, if full function does not return, a splint that fits in your shoe, known as an Ankle-Foot Orthosis (AFO) may be provided.

Although an AFO can assist with the drop foot to a similar degree as FES, it can in some cases make standing up from sitting and using stairs harder, as the shin can be prevented from moving over the foot. Because an AFO can restrict voluntary movement, muscles may become weaker through none use. It is believed this may also prevent recovery of voluntary movement.

Other treatment options include medication (Baclofen or Botulinum) or surgery.

Functional electrical stimulation

FUNCTIONAL ELECTRICAL STIMULATION (FES) uses small electrical currents to stimulate the nerves that connect to the paralysed muscles. This causes the muscles to contract. FES can be used to stimulate nerves in the arms, legs, trunk and buttocks in order to achieve a range of functional movements.

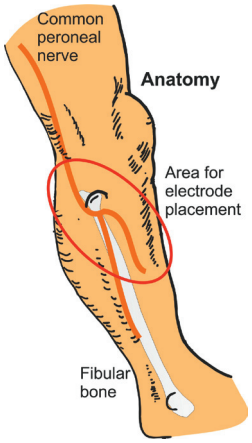
FES for drop foot correction

FES is particularly beneficial for drop foot. The peroneal nerve is easy to stimulate as it lies just under the skin and the lower leg muscles it supplies generally respond well enough to lift the foot at the ankle.

How does it work?

The FES current is generated by a small battery-powered electronic device. There are two ways of delivering the current to the nerve:

EXTERNAL FES. The most common way is to use electrodes placed on the skin over the nerve. It is important that the electrodes are accurately placed each time FES is used if the correct movement is to be produced. This requires either that the user accurately positions the electrodes for themselves, or they are aided by attaching a cuff below their knee that positions the electrodes on the leg. The user will experience a "pins and needles" sensation when the current is applied, which most people quickly become used to.



IMPLANTED FES involves surgery in which the electrodes are placed directly onto the nerves and controlled by a small implant placed under the skin. The FES device activates the implant through a wireless antenna worn on the outside of the body. Implanted devices remove the need to position electrodes on the skin each day. They also can significantly reduce or eliminate the sensation associated with external stimulation. External FES is used to test that walking is improved with FES before receiving the implant.

TRIGGERING. The muscles need to be stimulated to lift the foot at the right time during walking. So, the stimulation needs to be triggered when weight is taken off the foot until just after the weight is returned to the foot. This provides foot clearance when swinging the leg and ankle stability when the foot lands.

Two trigger systems are currently used. One uses a pressure sensitive foot switch that is placed in the user's shoe, usually under the heel. The foot switch and FES device can be connected either with a wire or using a wireless link. The second system for triggering is from the movement of the user's leg detected using a tilt sensor. The sensor is contained within the FES device mounted on a leg cuff.

The majority of FES users choose to use the device every day. However some people choose to use it for specific activities such as walking outside the house or at times when they need extra help with their walking. All FES devices can be easily turned on and off by the user. FES should be turned off when driving.

What does it involve?

In order to gain the most benefit from FES, indivduals must be able to walk a few steps. This can be with assistance and/or using a walking aid. People with less ability may use FES during physiotherapy sessions when learning to walk after their stroke.

Before you can be provided with a FES system, you will require a careful assessment by a FES specialist. They will ask you about your general health, medical history and what you are hoping to achieve with FES. They will consider whether it is safe for you to use FES. Precautions include pregnancy, active cancers, poorly controlled epilepsy, other implants such as cardiac pacemakers.

The clinician will attempt to find the position of electrodes on your leg that produces the best lift of your foot with the minimum intensity of stimulation.

When an effective foot lift is achieved in sitting, the clinician will then make sure the device triggers reliably whilst you are walking and that the foot clears the ground with every step. The clinician will then observe the way you walk with FES. They may need to make adjustments to the electrode positioning, stimulus intensity, or timing of the stimulation.

In some cases, they may need to stimulate an additional set of muscles, such as those that control the hip, knee or arm to further help you with your walking. It is usually quick and easy to establish whether FES will be helpful. Once satisfied with the outcome, the clinician will train you in the use and maintenance of your FES device.

Once you are provided with a FES device, it is common to record outcome measures such as walking speed, the effort of walking or questionnaire based measures at each clinic session.

If your walking improves with FES, this may enable you to engage in more activities. As a result, some further adjustments may be required to the FES device. For this reason it is important to attend regular follow up sessions. Follow up is normally 3 to 6 times in the first year, and then every 6 or 12 months thereafter.

What are the benefits?

Studies have demonstrated that FES for drop foot can lead to the following benefits:

- More natural walking pattern
- Improved walking speed
- Ability to walk longer distances
- Improved confidence
- Increased independence in activities of daily living
- Improved safety with a reduced incidence of falls
- Walking becomes less tiring
- Reduced spasticity
- Walking becomes easier on uneven surfaces
- A training effect – most stroke survivors after a period of using FES show an improved walking speed even when the FES is switched off. This effect might not occur with every user or be permanent.

Many FES users report that these benefits enable them to enjoy a better quality of life.

The evidence from these studies was reviewed by the National Institute for health and Clinical Excellence (NICE). Their published guidance states that drop foot FES is a safe and effective treatment. The "National Clinical Guideline for Stroke" published by the Royal College of Physicians also recommends FES for drop foot. A similar document has also been published by Health Improvement Scotland.

Are there any risks or side effects?

When using surface electrodes, the stimulation will be felt as 'pins and needles' and in the majority of cases is well tolerated. The use of surface electrodes can in a small number of cases lead to skin irritation. These cases are usually treated by changing the type of electrodes, the stimulation settings or by switching to the use of an implantable system.

Patients who undertake surgery for implantable FES devices are at the same small but recognised risks associated with any surgery and general anaesthetic.

How can I get FES?

Your GP can refer you to a number of NHS funded FES Services. However, in some regions, a FES service may not be offered or automatically funded for all FES devices available on the market. Your GP or treating specialist can make an individual funding request for any FES device on your behalfany FES device via this process., although there is no guarantee that your application will be accepted.

The range of FES devices can also be funded privately and are available through a number of physiotherapy clinics and other healthcare providers.

FES clinical guidelines

National Institute for Health and Clinical Excellence. Interventional procedures overview 278: Functional electrical stimulation for drop foot of central neurological origin. 2009. ISBN 1846298474
http://publications.nice.org.uk/functional-electrical-stimulation-for-drop-foot-of-central-neurological-origin-ipg278

National Institute for Health and Care Excellence. Clinical Guideline 162: Stroke rehabilitation - Long-term rehabilitation after stroke. 2013. ISBN 9781473101579.
http://guidance.nice.org.uk/CG162/NICEGuidance/pdf/English

Intercollegiate Stroke Working Party. National Clinical Guideline for Stroke, 4th edition London: Royal College of Physicians 2012. ISBN 9781860164927
http://www.rcplondon.ac.uk/resources/stroke-guidelines

Health Improvement Scotland. Evidence note 46. The use of functional electrical stimulation (FES) in adults with dropped foot. 2012.
http://www.healthcareimprovementscotland.org/programmes/clinical__cost_effectiveness/shtg_-_evidence_notes/evidence_note_46.aspx

List of FES suppliers

Bioness Inc.
0800 411 8100
http://www.bioness.com/United_Kingdom.php

Odstock Medical Limited
01722 439 540
http://www.odstockmedical.com/

Otto Bock Healthcare
01784 744 900
http://www.dropfoot.co.uk

Trulife UK
01142 618 100
http://www.walkaide.com

Statement
The content of this leaflet is based on a document authored by Mr Jon Graham (Clinical Director, PhysioFunction Ltd.), and commissioned for writing by the above suppliers of FES devices. The content has been checked and reviewed by leading FES clinicians.