Orthoses for neurological ankles

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ABSTRACT

Patients with weakness or abnormal posture of their lower leg may benefit greatly from appropriate orthoses. This paper describes the sorts of problems that can be helped in neurological practice and the range of devices commonly used, and also highlights some of the factors influencing selection. With greater understanding of their use, clinicians will feel more confident about referring patients for early orthotic assessment.

INTRODUCTION

An orthosis is a device that supports residual function, whereas a prosthesis replaces that function. Splints and prostheses have been used for thousands of years, for example, on an Egyptian mummy's foot from 2700 BC. Orthoses are now named according to the joints they work on: I will confine myself to ankle foot orthoses in neurological practice, and not consider diabetic complications, sports injuries and orthopaedic patients.

Orthoses can help many patients with poor control of the lower limb: there is often a biomechanical solution to a biomechanical problem, which can improve safety in standing and walking, while physiotherapy concentrates on motor learning. There has been concern that using an ankle foot orthosis (AFO) early after a stroke may impair recovery of normal muscle control; however, there is now good evidence that this is not the case[1 2] and early referral to orthotics service of patients who had a stroke with mobility problems is recommended.[3 4]

Foot drop in *swing* phase (while the foot is not in contact with the ground) is the most obvious indication for an ankle orthosis, but some patients may benefit more from improved stability during *stance* phase (while the foot is touching the ground, during part of which, it is taking all the body weight) by a 'well-tuned' AFO. This involves supporting the ankle and hence the knee at the best compromise of angles to stabilise the knee

Figure 1 Darco wedge shoe. Therapeutic trial before modifying patient's own footwear. Moves fulcrum of initial contact from behind to under ankle joint. Reduces load on tibialis anterior at initial contact.

Figure 2 Rocker sole. Moves fulcrum of initial contact from behind to under ankle joint. Also facilitates rollover when ankle is fused.

Figure 3 Plastic posterior leaf spring ankle foot orthosis. Cheap so likely to be kept in physiotherapy or orthotics stock for same day supply. Modest stiffness limits effect in stance. Safe for patients to buy from internet. Assumes ankle rests in neutral position.

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Figure 4 Thin carbon fibre ankle foot orthosis (AFO). Assumes ankle rests in neutral position. Thin lamination, so mild support of dorsiflexion in swing. Stiffer than a plastic posterior leaf spring AFO, so a little more effect in stance.

during mid stance phase, while permitting knee flexion at the beginning of swing phase.

EVIDENCE TO GUIDE CLINICAL PRACTICE

When considering orthotic options, the first question is whether there is need for compensation or control during *stance* phase of gait. These functions usually require a bespoke moulded AFO. Only when there is

Figure 5 Elastic foot lifter. Only helps in swing phase. Safe for patients to buy from internet. Works best with lace up shoes. Orthotix.co.uk.

Figure 6 Home made elastic foot lifter. Puppy collar and bungy cord.

Figure 7 Bespoke silicone ankle foot orthoses. Most often bought privately for aesthetic reasons. Dorset Orthopaedic Co Ltd.

Figure 8 Stiff carbon fibre ankle foot orthosis. Assumes ankle rests in neutral position. Thick lamination, much stiffer, so strong resistance to plantarflexion can overcome modest spasticity pulling into plantarflexion and inversion. Strong resistance to dorsiflexion allows ground reaction force to support knee extension in stance and may give some spring at toe-off.

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Figure 9 Custom moulded knee ankle foot orthosis. Moulded AFOs must be close fitting and cannot be used if oedema causes change in limb volume. This one also has a thigh corset; hence, it is a knee-ankle-foot orthosis. (KAFO) May allow use of several different pairs of shoes, unlike the caliper figure 13, made for the same patient to accommodate swelling.

no need for this, can one supply a simple stock device to support foot drop in *swing* phase.(table 1)

Published evidence emphasises the importance of optimising the alignment of AFO and footwear[5 6] and the stiffness of the AFO for individual patients.[7] Once this has been achieved, the available options may not permit a realistic comparison in a trial, or the patients become so highly selected that the results do not inform clinical practice.[8 9] The great majority of trials recruit ambulant patients who had a stroke with weak dorsiflexors, relatively normal range of movement, and little or no spasticity. The other group that has been extensively studied is children with cerebral palsy, commonly with crouch gait.[10] Systematic reviews[11–20] conclude that AFOs work better than nothing, even many years after stroke, and there are similar results with AFO and functional electrical stimulation.

The specific neuropathology causing the biomechanical problem rarely affects the orthotic prescription, other than when the pathology anticipates rapid deterioration. Then, prompt supply of a device that is

Figure 10 Custom moulded ankle foot orthosis. Big heel build up to accommodate fixed ankle plantarflexion.

Figure 11 Pressure relieving ankle foot orthosis. Prevents any pressure on back of heel to prevent or relieve pressure sore. Maintains existing ankle range and can be bent to accommodate fixed plantarflexion.

80% of ideal is better than a 3-month delay in supply of a device that would have been 90% of ideal when prescribed, but which no longer works as the patient has changed so much in the interim.

SWING PHASE

Weak dorsiflexors causing foot drop in the *swing* phase of gait may be supported by simple elastic foot lifters, stock plastic or carbon fibre AFO of low stiffness, bespoke silicone or Lycra, or functional electrical stimulation. The major factor influencing selection is patient preference among devices that their National

Figure 12 Caliper. External caliper and bespoke footwear for the same patient as figure 10, usable when leg swelling prevents use of close fitting moulded device.

Figure 13 Turbomed ankle foot orthosis. Worn outside shoe, said to facilitate sports and high activity. TurboMed Orthotics.com.

Health Service will offer, or what they are prepared to buy privately. Appearance is the most common concern,[21 22] but also important is restriction of movement that prevents them standing from sitting or

Figure 14 Contracture-correcting ankle-foot orthosis. Strong springs in joints beside ankle give powerful dorsiflexion force, but accommodates to voluntary or involuntary plantarflexion, unlike a rigid plaster cast.

Figure 15 Bespoke dynamic lycra 'lift up sock'. May improve ankle control if proprioception is facilitated by compression, otherwise only helps in swing phase. DM Orthotics.com.

getting up if they fall, comfort, feeling too hot, ease of donning and selection of footwear.

Functional electrical stimulation may be preferred over a rigid device because it is lighter, cooler, and does not take up much space in shoes[11]; however, it is not commissioned in all services, so patients may have to travel to supraregional clinics to try this. Functional electrical stimulation does not work with peripheral nerve, muscle or tendon lesions, or with high muscle tone in plantar flexors or inverters. It does not compensate for contractures and does not enhance stability in the stance phase of gait, and requires more competence from the patient to use it than

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Table 1 The main types of impairment seen in neurological orthotic practice are listed in approximate order of severity, noting problems in swing phase, stance phase and commonly used orthotic prescriptions

Impairment	Swing phase problem	Stance phase problem	Primary objective of orthosis	Solutions
Foot slap, for example, tibialis anterior tendinopathy	None	Uncontrolled plantar flexion at initial heel contact, then stable	Stop slapping noise: reduce the force that tibialis anterior needs to apply to control plantarflexion	Modify sole of shoe by moving point of initial contact anterior, towards line of action of tibialis anterior, reducing moment of rotation (figures 1 and 2) or simple AFO (figures 3 and 4)
Minor calf shortening, stable ankle	None	Calf discomfort in flat shoes, ascending slopes; knee hyperextension	Comfort in standing, prevent long term knee injury	Heel wedges inside normal shoes
Isolated low or normal tone foot drop, for example, some upper motor neurone lesions, peroneal neuropathy	Foot drop	Once foot flat on ground, stable	Prevent foot drop in swing	Elastic Lifter, posterior leaf spring (PLS), carbon fibre or silicone AFO (figures 5–7) functional electrical stimulation
Spastic plantar flexion but not inversion, little or no calf shortening	Foot drop	Once foot flat on ground, stable	Prevent foot drop in swing	Stiffer carbon fibre AFO±heel wedges (figure 8) functional electrical stimulation
Spastic plantar flexion and inversion, ±shortening, for example, late cerebral palsy, multiple sclerosis	Spastic plantarflexion and poor hip and knee control	Initial contact with lateral forefoot, may not get heel to ground	Support foot in optimal position, compensate for lost range, facilitate knee flexion in late stance	Moulded AFO (figure 9)
Very weak plantar flexors, low tone, unstable ankle for example, Charcot-Marie-Tooth, Guillain-Barré syndrome, Duchenne muscular dystrophy	Foot drop, difficulty lifting weight of leg	Unstable base of support at ankle	Compensate for weak plantar flexors in stance, as well as foot drop in swing	Strong, stiff carbon fibre (figure 8) or moulded if loss of normal passive range, figure 9)
Weak quadriceps and ankle muscles, for example, poliomyelitis, Guillain-Barré syndrome	Foot drop, difficulty lifting weight of leg	Unstable base of support at ankle and knee	Stabilise knee in stance	AFO is aligned to use ground reaction force to keep shin upright and hence knee straight: strong, stiff carbon fibre (figure 8) or moulded if loss of normal passive range, figure 9
Marked loss of range, for example, fixed plantar flexion but within normal range for 'standing on toes' and inversion, for example, late cerebral palsy	Dwarfed by difficulty in stance phase and control of entire limb	Unstable base of support due to small weight bearing area	Permit standing for transfers, therapeutic standing in frame	Stretch by serial casting + botulinum toxin, surgery. Moulded AFO with big heel build up (figure 10).
Fixed in extreme plantar flexion±inversion, for example, late after adult hypoxic brain injury	Only swing phase is when hoisted for transfers	No usable weight bearing area, unable to stand	Permit therapeutic standing in frame and keep feet on wheelchair footplates	Surgery, no AFO
Risk of calf contracture and heel sore while bed bound	Nil	Nil	Maintain ankle range	Pressure relieving or resting AFO (figure 11)
Leg swelling, volume fluctuation	Varies	Rigid AFO does not fit consistently	Usually control ankle in stance phase	External caliper or plastic AFO (figures 12 and 13)
Calf contracture	Varies	Cannot get heel to ground	Regain lost range	Contracture correction device, applying sustained calf stretch (figure 14)
Active patient, for example, running	Foot drop	Good function	Not break during high impact activities	Robust springy external AFO, Turbo Med (figure 13)
Poor ankle control, which responds to compression, perhaps improving proprioception	Variable foot drop	Adequate power but poor control	Optimise active muscle control	If positive response to Tubigrip, bespoke Lycra stocking (figure 15).

The orthotics options are shown in figures 1–15.
AFO, ankle foot orthosis.

a mechanical device. Hence, only a small proportion of patients with poor ankle control use it.

STANCE PHASE

When an orthosis aims to compensate for loss of normal passive range of movement, to resist higher muscle tone or to control ankle and knee movement during the *stance* phase of gait, a bespoke moulded AFO is usually made. When higher forces are necessary to control the ankle and knee posture in stance, these must be applied over as wide an area as possible. Hence, moulded AFOs are designed to fit closely all around the sole, heel, sides of the foot and ankle, sides and back of lower leg.

When the size of the lower leg fluctuates due to oedema or joint swelling, a close fitting moulded AFO should not be used because it cannot expand or contract to accommodate change in size. If oedema can be controlled with a compression stocking or diuretic

Key points

- Orthoses can help get people back on their feet early after new impairment.
- Early use of orthoses does not impair subsequent recovery of weak muscles.
- Consider referral to orthotics whenever referring to physiotherapy.
- Modern devices offer better aesthetics and function than old fashioned calipers.

Further reading

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medication, a moulded AFO may fit more of the time, but an external caliper, made for a single pair of shoes, is often the only option.

WHEN TO REFER TO AN ORTHOTICS SERVICE

It is safe for patients to buy or physiotherapists to supply devices to support foot drop during *swing* phase, as comfort and appearance are the main factors influencing patient satisfaction. However, AFOs to control the limb in stance phase require assessment and prescription by an orthotist due to the much higher forces involved and potential for making the situation worse, with skin breakdown, less stable gait, loss of confidence and musculoskeletal pain.

Referral for orthotic assessment is often late,[23] for instance after waiting to see how much improvement occurs with time and physiotherapy. Orthoses may improve the effectiveness of early rehabilitation, for instance by allowing safe weight bearing through a weak limb for transferring with a Rotastand, and reducing the risk of injury during gait training. With greater understanding of their use, clinicians should feel more confident about referring patients for early orthotic assessment.

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