Review

Rehabilitation of Neuro-mobility

Uditha Jayatunga[1]

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Neurological disability is multi-dimensional. These include mobility limitations, upper limb dysfunction, swallowing, speech, vision, hearing, continence, cognition and behavioural issues. Out of all these, regaining mobility is of paramount importance to most patients. Regaining mobility is vital for patients not only to walk but also get back to normal life as much as possible, to maintain family, work and social responsibilities as well as to live independently as possible. Additionally, there are psychological and physiological benefits of maintaining bipedal mobility.

Normal gait requires that many systems, including strength, sensation and coordination function in an integrated fashion. Locomotion in humans is based on spinal pattern generators, which are regulated by supraspinal control. Corticofugal, basal ganglia, cerebellar, vestibulospinal and reticulospinal controls are all important in normal bipedal walking. The control of walking must thus involve motor cortex (possibly the supplementary motor area on the medial surface of the frontal lobe which gives rise to diagonally opposite movements of arms or legs when stimulated), the cerebellum, subthalamic region, midbrain, noradrenergic reticulospinal tract and the spinal locomotor centre. Neurological mobility disorders could be due to isolated motor weakness, paralysis, spasticity, ataxia, sensory deficits, dyskinetic movements, coordination and balance disturbances or a combination of many factors.

From a Rehabilitation Medicine management of neuro-mobility, many facets need to be addressed in order to optimise mobility. Observing how patient is mobilising is the most important part of neurological examination. Types of gait disorders are hemiplegic or diplegic scissoring gait in spastic conditions, festinent gait in Parkinsons, Trendelenburg or waddling gait or lordotic gait in muscle disorders, high stepping gait in sensory disorders, broad based ataxia in cerebellar disorders, choreiform gait in hyperkinetic gait disorders. When observing their gait, it is important to look at the speed, stride length and cadence. Beyond this you need to look at spasticity related altered body postures, bed and wheel chair seating postures, seating balance, ability to stand from seating posture, transferability and technique, ability to remain standing and the standing posture. A wide base may indicate cerebellar or proprioceptive loss.

There are many mobility related scales we use such as Rivermead Mobility Index which is a 15-point scale which assesses the ability to turn in bed to running 10 meters. Depending on the condition of the patient, we could use many other simpler scales such as 6-meter timed walk test or Timed up and Go (TUG) test or other mobility associated scales such as Berg balance scale looking at the balance of the patient. At the higher end of the spectrum, we could use facilities such as Gait analysis to optimize and fine tune mobility of some patients. Beyond this, we also need to look at social mobility including getting back to driving.

Any improvement in the ladder of such mobility scales will improve the quality of life and independence. Hence a patient who could not turn in bed independently (Rivermead 1) to improve up to being able to sit at the edge of bed independently (Rivermead 3) could be considered significant progress. Such improvement will also reduce the patient getting pressure sores, ability to eat seated as well as improving lung functions. Similarly if a patient improves from being able to walk 10 meters (Rivermead 7) to walking on uneven ground (Rivermead 12) is a significant improvement though overall mobility is much less than if they previously had normal mobility.

For a successful mobility neuro-rehabilitation program, it should have access to not only to multi-disciplinary teams but also many other facilities. These include orthotics (splinting), walking aids, specialist wheelchair services, medications and spasticity services, a gait lab, functional electrical stimulation service, access to orthopaedic and neurosurgical services and disability driving assessment service. Such facilities are very important to maximize the potential of the patients, which is the overall goal in Rehabilitation Medicine. It is also vital to recognize the environmental limitations patients have which could limit their mobility. It is routine for our occupational therapists to look at home as well as work environments if needed to maximize their potential.

It is important to recognize that any underlying condition causing mobility problem needs appropriate management where possible – such as in spinal cord compression, Guillain Barre Syndrome or Parkinson disease.

[1]*Consultant in Rehabilitation Medicine, University Hospitals of Derby and Burton NHS Trust, UK.*
Correspondence: E-mail: udithajayatunga@ntlworld.com

Therapy

In neuro-rehabilitation, multidisciplinary input is essential at all stages for holistic management which includes mobility disorders.

For mobility issues, this MDT team should generally consist of a physiotherapist, occupational therapist, orthotist and the Rehabilitation Medicine consultant. At times depending on the issues, others have to be incorporated such as the orthopaedic surgeon, wheel chair OT/technologist, psychologist and gait analysis team members. Specific achievable goals should be planned and discussed within the MDT team as well as with the patient. Many patients need long term follow up by the Rehabilitation Consultant who may in turn get either the MDT or individual therapy members involved depending on the specific issues. For many long term conditions, patients cannot be given life long therapy input due to limited resources. Such patients are given therapy exercises for them to maintain their potential. If patients deteriorate due to natural progression of the condition or due to any other factors, then patients should be able to access top up therapy.

Drug management

Drug management of mobility issues are predominantly related to management of spasticity. In generalized spasticity affecting mobility, we would use many antispastic agents such as Baclofen, Gabapentin, Tizanidine, Danthrolene and Diazepam. It is important to remember that spasticity in some circumstances will help the patient to maintain mobility and hence needs careful evaluation.

Botulinum toxin is used for focal spasticity. Commonly in lower limbs, the adductor, hamstrings, gastrosoleus muscle and posterior tibial muscles are injected. These most often need to be used in combination with suitable splinting. Some patients may have troublesome striatal toe or toe clawing which needs treatment. Botulinum toxin is expensive and hence it is vital to make sure goals are clarified and met for continuation of treatment. For patients who are wheelchair bound, Botulinum toxin injections can help to improve seating posture, prevent pressure sores and hence improve overall quality of life. Injecting the upper limbs too could potentially help mobility. An example is, if we could help them to extend their forearm by injecting biceps or brachio-radialis, it may help them to use a Zimmer frame.

There is a small group of patients with conditions such as spinal injuries or multiple sclerosis where it is difficult to manage their spasticity with either oral medications or Botulinum toxin injections. They have to be considered for intrathecal baclofen pump (ITB) which is highly effective in controlling underlying spasticity. It is very expensive and usually they need a test dose before implanting the pump. Few patients can get back to bipedal mobility but for majority of patients, ITB will help with their wheel chair seating and mobility. Troublesome spasms or postures could be some of the reasons where they cannot sit out for a long time, which could be well controlled with ITB pump (as below). These pumps are not only very effective but also could give hourly varying doses to fine tune their management. Once stable, side effects are minimal, however they need regular filling of their pump port which is usually placed in the anterior abdominal wall.

Before ITB

After ITB

Gait analysis

This is an important tool in the management of complex mobility problems such as in cerebral palsy patients. About 85% of cerebral palsy patients do have spasticity related gait disorders. In others who have cerebral palsy related dyskinesia or ataxia, complex gait analysis is less useful. Gait analysis is time consuming, but we could get multiple data from dynamic force plate, 3D motion analysis, surface EMG, joint angles and pedar pressure monitoring. From gait analysis we could objectively assess the deviation from normal mobility at all levels. A typical gait cycle is broadly divided into the swing phase and the stance phase. Walking requires an upright position with fully functioning anti-gravity muscles and intact postural reflexes. A greater amount of time is spent in the stance phase with the stance phase contributing to about 60% of the gait cycle and the swing phase contributing to 40%.

Gait analysis is a very important tool for assessment of complex gait, to monitor progress, plan treatment and interventions, monitor effectiveness of treatment and prevent complications. The interventions following gait analysis, may include injections for spasticity, Functional Electrical Stimulation (FES), orthotics, physiotherapy, surgical interventions or a combination of the above.

Functional Electrical Stimulation

This is a technique which is now being widely used in rehabilitation. Many patients who are mobile with underlying spasticity may have spastic foot drop. Such pattern is typically seen in stroke patients who have hemiplegic gait with spastic foot drop, circumduction and hip hiking. If you fail to control with simple AFO and other therapeutic measures, they could be considered for single channel FES where the common peroneal nerve is stimulated using a switch in the insole to produce dorsiflexion of the foot during swing phase of the gait cycle.

FES system

In some patients it could have a dramatic effect. In general, in stroke patients, FES improves walking speed by 16%, reduces the effort of walking by 29%, improves confidence and reduces falls. Bilateral FES and multi-channel FES systems are also in use but they are more complicated to use and need a lot of determination by the patient. Advanced systems are being implanted, which have more user friendly versions and they give better results.

Orthotics

Orthotics play a key role in the overall management of most patients, in both acute and chronic stages as well as in upper or lower motor neurone lesions and myopathies. Hence it is vital to have the back up of a good orthotic department. They could be used alone in lower motor lesions such as foot drop due to common peroneal nerve palsy or in combination with botulinum toxin or other medications in upper motor neurone lesions.

Orthotic prescription will be determined by a discussion with the patient and an assessment of gait kinetics, manual muscle testing and joint range of motion. There is a huge range of orthotics, from simple foot insoles to complex reciprocating gait orthosis where when one flexes while other knee extends, used by cerebral palsy patients. More extensive orthosis such as Knee Ankle Foot Orthosis (KAFO) or Hip Knee AFOs (HKAFO) are used by post-polio patients, patients with myo-pathies, spina bifida, spinal lesions and cerebral palsy. Most of these are individualised orthosis and they sometimes need perfecting over many sittings due to complex biomechanics of mobility. Many users of extended orthosis depend totally on their orthosis to maintain their limited mobility.

Commonest form of orthosis is Ankle Foot Orthosis (AFO) used for patients having foot drop. A range of these are available to address differing biomechanics of these patients. Some need regular tweaking from the orthotists to make sure they fit well. In acute stages, orthosis also have a critical role in the prevention of contractures and many patients are given night splints such as 'foot up' splints as a preventative measure. Some patients may also identify their walking problem as due to knee instability. This may be due to the knee giving way or related to hyperextension, which can cause pain. There is a lack of evidence on orthotics for the management of knee instability related to neuromuscular disorders on pain and falls but control of knee alignment through use of rigid AFOs or through knee braces can be successful.

Patients with polyneuropathy commonly present with changes to the alignment of joints, which can lead to pain, instability or callous build ups under the feet. Custom insoles are an effective treatment of cavus foot

pain and its associated limitation in function by reducing and redistributing abnormal ground reaction forces.

Wheelchairs and specialist seating

Wheelchairs are very important for many patients. Most spinal injury patients are totally dependent on them while others do use it intermittently for indoor or outdoor mobility. There are many categories of wheel chairs and most individuals with good seating balance and upper limb function can use a standard self-propelled wheel chair. Others who are dependent on wheelchairs all day, need many other modifications to keep them comfortable and prevent pressure sores. Uncomfortable wheelchairs also could precipitate troublesome spasms. This is where specialist seating systems are needed. Hence it is absolutely vital for a Neuro-rehabilitation service to have access to a specialist wheelchair service. One of my patients, who has Duchenne's Muscular Dystrophy with severe weakness and could easily have been bed bound, has a well-adapted power chair for his needs. With this he goes all over UK conducting inspirational talks and also been to the parliament to lobby ministers. None of this would have been possible, if he did not have his accommodating powered wheelchair which he controls by head movements. Within limitations, his wheelchair allows him to maximize his quality of living.

Head, trunk and pelvic supports

Moulded seating

For a quadriplegic spinal injury patient, he may need head, trunk, pelvic and foot supports. Additionally, he will need a suitable pressure relieving cushion to prevent pressure sores. For a severe cerebral palsy patient with scoliosis, he will need to moulded wheelchair to accommodate posture, if it cannot be corrected by surgery. Additionally, to improve quality of life, for patients who do not have good upper limb function to self propel, powered wheelchairs are available which could be operated by either a joystick or other means.

Surgery

Surgery plays a vital role in a small number of patients with mobility disorders. Surgical interventions could involve bone, muscle, joints, ligaments, tendons or nerves. The goals of surgery may be to improve pain, minimize impairment and maximize motor function, increase muscle strength and control tone as well as spasticity and to promote self-care. Some are to improve bipedal mobility whereas others could be to improve wheelchair mobility by improving seating such as scoliosis corrective surgery. Implantation of ITB pump also falls into surgical intervention category. In severe spasticity, some are referred for dorsal rhizotomy. In many complex mobility disorders such as cerebral palsy, surgical interventions are done either over many years as new problems develop or sometimes done as single event. Surgery needs to be followed by therapy input

including splinting to optimize benefits. Examples of lower limb surgical interventions include femoral and tibial derotational surgery, osteotomy, tendon releases, tendon transfer/ lengthening, arthrodesis as well as a variety of foot surgeries particularly in conditions such as Charcot Marie Tooth Syndrome.

Mobility and other aids

Most bipedal patients use a wide variety of mobility aids depending in their overall mobility as well as balance. These have to be ideally assessed by the therapists. These include a simple walking stick to a gutter frame. Most help mobility by widening the base to give stability when walking. Additionally, for patients to function at home, some patients need hoists or stair lifts. Hence it is important for an occupational therapist to visit patients at home to make suitable recommendations.

Driving adaptations

Getting back to driving is also an important goal for many who may have had an acute disability. Hence it is a vital part of disability assessments. They are referred to disabled driving services to make recommendations. There are multiple driving adaptations available directly reflecting on their neurological disability as well as various other transfer and storage adaptations for wheel chair bound drivers. All these help them to improve their quality of living by helping them to get back to work or earn a living or by giving better social mobility.

Environmental adaptations

Environment itself disables many patients within their home as well as outside. Once again occupational therapist will have a huge role to play by assessing the home environment. For a person in a wheelchair even a small step will be a huge challenge. They may recommend simple ramps and grab rails to overcome some of these problems.

Conclusion

Mobility in neuro-rehabilitation ranges from bed mobility to high end activities such as running. For some, due to lifelong disabling conditions and for others it could be following an acute event. Multiple interventional modalities from simple to complex ones are available in isolation or in combination which should be delivered within a MDT team taking holistic needs into consideration. Such a service delivery should be able to optimise mobility within the limitations of patient's background pathology.

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