IAPMR Guidelines

Practical Management of Gait Disorders in Hemiplegic Patients

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Gait abnormalities in stroke patients are common and contribute a large share to the morbidity experienced by these individuals. Many stoke survivors are able to walk after varying periods of the stroke episode but very few are competent walkers in all scenarios. Ability to walk is the most important factor which determines return to work in these patients.[1]

Basics:

Neural control of walking involves basic stepping patterns, equilibrium and adaptability. [2] Persons with hemiplegia have problems with all of these parameters which preclude them from walking efficiently. They have been reported to have increased stride times, reduced walking velocity, reduced cadence, increased time spent in stance phase in non-paretic limb and decreased time in swing phase in paretic limb leading to marked asymmetry in walking. [3] As a result, gait is inefficient leading to disproportionate energy expenditure and fatigue which further reduces motivation of these individuals to walk making them prone to develop secondary complications of immobility.

Studies of kinematic data tells us that persons with hemiplegia may have decreased hip extension, abnormal lateral pelvic displacement, abnormal knee flexion and decreased ankle plantarflexion in the stance phase due to inability of the prime movers to generate sufficient tension or due to adaptive shortening of the antagonist muscles. [4] Similarly, the swing phase is also characterised by decreased hip flexion, decreased knee flexion in early swing, decreased knee extension in late swing and decreased ankle dorsiflexion due to similar reasons. [5] Careful study and documentation of the above sets the stage for using various interventions to alter these and improve gait.

Problems and tackling methods:

1. Spasticity is a major concern interfering with gait. Physical measures help in reduction of spasticity as well as improving strength and gait. Muscle stretching – passive or active, positioning with splints, casting, resistance training and strengthening exercises, biofeedback techniques, physical agents like heat and cold application and electric stimulation application play a useful role in managing spasticity. [6] Functional electrical stimulation has been reported to improve ambulation in non-ambulatory patients in combination with other therapeutic methods. [7]

2. A number of drugs which act through varied mechanisms are available for decreasing spasticity. Inspite of their usefulness in terms of relative ease of administration, cost and patient acceptability,

they tend to be sedating and interfere with cognitive processes and recovery. They also act in a systemic manner causing generalised weakness. In some cases, spasticity might be helping the individual maintain his stance position and using a systemic alternative might interfere with this activity and setback any gains accrued.

3. Treating spastic muscles focally which interfere with gait patterns is desirable. It allows specific muscles to be targeted without causing generalised weakness or systemic toxicity. It also improves temporal gait parameters and allows a more functional pattern to emerge. A study on chronic hemiparetics (more than 2 years after stroke) showed that injecting botulinum toxin in their ankle plantarflexors and invertors allowed them to achieve dorsiflexion of the ankle and improved efficiency of their gait. [8]Botulinum toxin injections have also been combined with electrical stimulation of ankle dorsiflexor and found to be superior in terms of reduction in tone and improvement in gait parameters. [9] A randomized study of 35 subjects with hemiplegia showed that improvement was greater when botulinum toxin injection was combined with stretching, strengthening and task specific walking activities. [10] The same group in another study showed that in chronic hemipleigia repeated botulinum toxin injections produced better results than single injections beyond 3 months. They reported that although decrease in tone according to modified Ashworth scale was similar after repeated injections, temporal gait parameters improved after repeating botulinum toxin injections. [11] Chemical neurolysis with phenol to control spasticity of large muscle groups in lower limbs is another option in these patients especially in those muscle groups which exceed the dose of botulinum toxin that can be safely administered. [12]

Physical approach:

A number of physical therapy measures like functional training, active and passive stretches, cardiac training, neurophysiological techniques and various orthotics and gait aids are routinely used in management of gait problems in these patients. Physical rehabilitation measures were found to be more effective than no intervention and whose effects persisted beyond the intervention period. A dose of 30-60 minutes per day for 5 to 7 days per week was effective. No single approach was more (or less) effective for promoting recovery of function and mobility after stroke. [13] However overground physical therapy gait training showed no improvement in gait functions in chronic stroke patients. [14]

Functional approach:

Traditional approaches have now given way to what are more functional methods of gait retraining. Task specific repetitive approaches like body weight supported treadmill training and robotic gait training, which aim towards faster and more functional gait achievement are currently more popular approaches. [15] This has altered the approach to treatment of spasticity as well. General spasticity inhibition is no longer desirable and treatment of spasticity which interferes with specific goal attainment with more focal measures is being attempted more.

Advanced approach:

1.Conventional gait training is laborious and does not always achieve intended results. Robotic training is said to be intensive, repetitive and task oriented. Assist-as-needed robots assist or correct the movements of the user, thus simultaneously activating motor and sensory

pathways.In a study of 30 individuals it was shown that robotic gait training improved some gait parameters and provided better work-out of the cardiovascular system as compared to conventional gait training. [16] A review article has proposed that more constraining robots like Lokomat help in the beginning of rehabilitation in patients with minimal or no recovery and other methods like body weight supported treadmill training help in more advanced patients.[17] Another large review of 23 trials concluded that electromechanical gait training (robotic therapy) is most beneficial in the first 3 months of stroke. It benefits subjects who are not able to walk to achieve some walking. It does not seem to affect gait efficiency or speed in already ambulating individuals. [18]

2. Problems with standing balance arealso observed in stroke patients. Balance retraining in stroke patients helps in achieving independence in performing activities of daily living (ADL). Balance retraining apparatus may be simple force platforms or sway systems which challenge the visual and vestibular compensatory mechanisms in addition to the proprioceptive system. In a study of 41 ambulatory stroke patients at around 3 months, trained in smart balance master for 2 weeks showed improvement in dynamic balance with visual feedback and self care activities which was sustained at 6 months of follow-up. [19] Review of 7 trials of individuals trained on force platform showed improvement in stance symmetry but no improvement in clinical or functional outcomes. [20]

3. Body weight supported (BWS)treadmill training is another option to improve gait performance in hemiplegics. It consists of a harness to unload the subject who is then made to walk on a treadmill at self-selected speeds. A review article has suggested that BWS helps those subjects who are already ambulatory to improve their walking velocity and endurance. It does not seem to help in achieving ambulatory potential in non-ambulatory individuals. [21]Underwater treadmill gait training is another interesting method used to gait retraining. It is also reported to be beneficial in already ambulatory patients. When compared with traditional treadmill gait training, it shows improvement in stance phase variables in the paretic gait rather than functional or walking abilities. [22]

4. Constraint induced movement therapy (CIMT) similar to the upper limb can also be used for the lower limb where the non-paretic limb is constrained and the paretic limb is forced to be used for 90% of waking hours in a functional manner. A review of CIMT in lower extremity for stroke patients has suggested that CIMT be used for gait retraining as soon as the subject assumes upright position to avoid “learned misuse” i.e. an asymmetric gait pattern that hemiplegics tend to acquire during initial gait training. [23] Use dependent cortical reorganisation is presumed to be behind motor improvement in these patients.

Most of the strategies enumerated above form part of the traditional “bottom-up” approach to gait rehabilitation where distal interventions (on the lower limb) are carried out to influence outcomes at the top (recovery in the brain). Some state of the art centers are pursuing the “top-down” approach. Brain-Computer interface (BCI) is a system where brain signals are detected through electroencephalogram, (EEG) electrocorticogram, (ECoG) functional magnetic resonance imaging (fMRI) or functional near-infrared spectroscopy (fNIRS) and decoded by a computer into a behaviour (walking).These systems are coupled with a robotic device and when the system detects an intention from the brain to initiate a particular movement, the robot initiates the same. [24] Currently, these systems are used for upper limb retraining, but lower limb retraining is also possible.

Pharmacological agents which influence the dopaminergic, noradrenergic or serotonergic systems promote motor recovery through the “top-down” approach. Drugs such as Levodopa, nortryptiline, fluoxetine are found to be useful in promoting motor recovery.[25] Non-invasive brain stimulation like transcranial magnetic or direct current stimulation modifies brain activity and neuronal plasticity through ipsilesional cortical activation and contralesional cortical suppression. When combined with task specific training, these techniques have been found to be useful in improving gait in stroke patients. [26]

In our institute, we follow best available evidence for gait training in stroke affected patients. We start with medical management to facilitate motor recovery, manage spasticity with drugs or botulinum toxin injections with or without orthosis and casting. This is in conjunction with robotic gait training if they are non-ambulatory apart from conventional physical therapy. After they regain ambulation, they may be offered treadmill training and balance training as necessary alongwith endurance exercises to improve their performance. Published literature by the author on gait training with treadmill and balance training on force platform and other rehabilitation interventions indicates good outcome for mobility in chronic stroke patients. [27,28,29]

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