Introduction

Spasticity is a major challenge for patients with neurological problems. Children with cerebral palsy (CP) always encounter different degrees of movement disorder in the presence of spasticity. However, spasticity is not all evil for those with neurological deficits. It could act as a brace to support the individual’s weight for transferring or walking. Therefore, a detailed assessment and motion analysis is essential in generating a specific goal for spasticity management that should be started as early as possible to prevent irreversible changes in musculo-skeletal system which will further distort the biomechanics of movement.

The role of physiotherapists in assessing function, defining disability, undertaking biomechanical assessment and providing mobility aids/casting/orthoses and motor training/stretching exercises is critical for the success of medical and surgical interventions for spasticity management.

Spasticity and Functions

More than 80% of children with cerebral palsy in Hong Kong belong to the spastic type. Spasticity prevents or limits the development of motor function. Management of spasticity for children with CP aims at improving the biomechanical alignment of the body and in turn improves functions. According to the International classification of Functioning, Disabilities and Health (ICF), a treatment goal should be set at improving the Activity and Participation level of patients. Each party may have different goals - able to move by whatever means such as rolling, crawling or creeping and to reach out for toys may be the first goal for a child; to be able to walk and start schooling is the most important for parents while for health care professionals, it is most imperative to prevent deformity and delay surgical intervention. All these goals should be aligned to generate a holistic and comprehensive treatment regime for the children with CP.

Role of Physiotherapy in Spasticity Management

There are 2 components of hypertonia - neurogenic and biomechanical. The neurogenic component refers to the overactive muscle contraction and biomechanical component the stiffening and shortening of the muscle and soft tissue. If these are left untreated, a vicious cycle is triggered off by the unopposed contraction of spastic and dystonic muscle groups leading to an abnormal limb posture, and in turn worsen soft tissue shortening and biomechanical changes in the contracted muscles. This further prevents muscle lengthening and perpetuates tonicity. There is indeed no time to lose. At our first assessment, we should confirm that spasticity is hindering functions. Secondly, the pattern of spasticity is analysed to see if it is generalised, focal or multi-focal.

Massage, myofascial release and acupressure are manual techniques that can reduce tone immediately. Passive stretching programmes, splintage and positioning are all essential in prevent deterioration of body alignment. Facilitation of active control of the limbs and strengthening exercises to the trunk and limb muscles are essential in promoting functional movement of children with CP.

If physical treatment alone is not sufficient to overcome the increased muscular tone or its mechanical consequences, particularly in moderate to severe spasticity, medical treatment and other interventions should be considered early. Intramuscular botulinum toxin injection is a treatment of choice for focal spasticity. Its effect lasts 2 to 3 months during which there is better motor control and allows intensive therapy. Functional gain can be observed even after the effect wears off.

Physiotherapists also have a major role in selecting candidates for selective dorsal rhizotomy (SDR) and to lead these children throughout the long course of intensive physiotherapy that follows.

Early Intervention with Botulinum Toxin

How early should we intervene? How do we know if spasticity is interfering or facilitating functions? Most health care professional or carers target at standing and walking while ignoring the important role of crawling for kids with which they explore the environment and

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**International Classification of Functioning, Disability and Health (ICF)(2001)**

- **Body Function & Structure**
- **Activities**
- **Participation**

**Environmental Factors**

**Personal Factors**
learn from it. Crawling exercise builds up both core and girdle muscles in preparing for a better development of gross motor function. Patients need good power and control in the shoulder girdle so that they can move in and out between 4 point kneeling and sitting position, to rotate body on sitting posture with one arm support and to reach for toys. The core muscles and the pelvic control are important in preparing for standing and walking. Therefore, treatment to improve the upper limbs weight bearing and hip dissociation may be the first goal that needs to be addressed. Spastic muscles over the upper limbs such as the biceps, brachialis, flexor carpi ulnaris, pronator teres and quadratus may be examined and considered for focal injection with botulinum toxin to improve the elbow and wrist extension for better weight bearing during crawling. To promote the lower limbs movement during crawling, hip adductors and iliacus may also be considered for injection.

Sitting is also an area we need to emphasise for those with spastic diplegia. Ability to sit stably and play with toys facilitates learning. Mothers would be happy to see a baby sit properly for feeding and a good alignment in sitting prevents spinal deformity. Spasticity of lower limb muscles - hamstrings, hip adductors and iliopsoas - hampers sitting posture. These kids either sit with a round back (photo 1) because of the pull from the hamstrings muscle or they compensate with “W” sitting posture (kneel sit) so as to alleviate the pull from the spastic muscles. Botulinum toxin to proximal muscles of the lower limbs such as hamstrings, hip adductors or iliacus will help to adjust the spinal alignment while sitting and with proper sitting posture, trunk muscles could be effectively trained.

Most of the previous studies concentrated on the result of spasticity management to lower limb muscles and its relation to walking. The use of outcomes measure is similar in each study. In both domains of activity and participation, they used Gross Motor Function Measures (GMFM) to measure changes in motor function. Three dimensional (3-D) gait analysis or the Physician Rating Scale (PRS) by the use of video recording were also common tools in measuring changes in gait pattern. However, seldom would studies mention the early intervention of botulinum toxin to prevent the deformity of the foot arches. Children with spastic diplegia always have increased muscle tone over both calf muscles which cause equinus gait pattern with collapse of medial foot arches. Early botulinum toxin injection of the gastro-soleus muscle followed with casting can effectively prevent and delay the deformity of the feet. This should be done as early as weight bear and before independent walking when they are aged around one to two.

When a patient is able to walk, with or without aids, at level I, II and III of Gross Motor Function Classification System for Cerebral Palsy (GMFCS I, II and III), 3-D gait analysis is useful in documenting the fine changes in lower limbs kinematics and kinetics. It is also helpful in analysing the movement pattern and deciding which muscle groups need botulinum toxin injection, at a single or multiple levels. A prospective study at Tuen Mun Hospital concluded that botulinum toxin is useful in improving the gait pattern and GMFM, most effectively within 3 months after injection.

Multilevel Botulinum Toxin Injection

Walking involves a sequence of muscle contraction and relaxation and in children with CP, weakness, spasticity, poor control, incoordination and impaired proprioception come into play. A detailed examination gives physiotherapists a general picture of limb function so that different muscle groups that require botulinum toxin injection could be mapped out and an appropriate treatment plan formulated. Recent study showed that multilevel botulinum toxin is effective in managing the problem in children with lower limb spasticity.

A typical deviated gait pattern is the flexion of the knee during midstance, either crouch pattern or jump knee pattern. This is often caused by muscle imbalance resulting from a combination of spasticity of flexor muscle (iliopsoas, hamstrings) and weakness of extensor (glutei, quadriceps, gastro-soleus) leading to fixed muscle contractures during development and further deterioration in mobility. After thorough examination and confirmation with gait analysis, muscles targeted for injection are usually the iliopsoas, hamstrings and gastrocnemius. Soleus is skipped if true crouch pattern (dorsiflexion of ankle joint in midstance) is noted to avoid further weakening the muscle.

After injection, intensive physiotherapy, serial casting followed by orthoses are indicated for optimal effects on the muscle strength and length. The change in
Selective Dorsal Rhizotomy

After a series of tone management with intensive physiotherapy punctuated with botulinum toxin injections, the child would probably be around 4 to 5 years old and selective dorsal rhizotomy (SDR) can be considered. A suitable candidate for SDR is typified by 6 S’s –

S(s) - Spasticity is still a problem;
S - Strong good strength of lower limbs and trunk muscles;
S - Straight able to stand straight with good alignment;
S - Slim not too fat in body build;
S - Smart intellectually good enough for carrying out training;
S - Support best result for one with supportive family and carer for postoperative intensive training.

Those with severe dystonia, dyskinesia or significant fixed orthopaedic deformity are not suitable candidates.

The team at NTWC has, to date, done the largest number of SDR in Hong Kong. Separate teams of physiotherapists are involved with the assessment and the actual training of patients to avoid bias in our prospective study. Under the domain of body structure and function according to ICF, we documented the changes of muscle tone, range of motion, strength and the selective control of the lower limbs. We perform gait analysis, oxygen consumption test, GMFM to measure the change in activity level. On participation level, Canadian Occupational Performance Measure (COPM) - a family-centred tool that guides participants to identify difficulties in their self-care abilities, school participation, and leisure activities - and Paediatric Evaluation of Disability Inventory (PEDI) are used. Our result is promising and has been published.

Summary

Spasticity management for children should be started as early as possible. Expertise in movement analysis and multidisciplinary collaboration in defining a practicable goal based on the ICF framework is essential in achieving good outcome. Timely intensive physiotherapy training is a key to success.

*NTWC – New Territories West Cluster consists of Tsuen Mun Hospital, Pok Oi Hospital and Castle Peak Hospital under the Hospital Authority

References