ROLE OF RELAXATION DURING THE TREATMENT OF CHILDREN WITH CEREBRAL PALSY

ABSTRACT:

During the clinical examination, the manipulations used for muscle relaxation enable the specialist to assess the stretching capacity of different muscle groups. When the treatment begins, these manipulations aim at correcting the posture, initiating and developing movements in the most natural way. They also facilitate the improvement of the patients' well-being.

Keywords: Cerebral Palsy (C.P.), spasticity, relaxation, automatic relaxation, neurofacilitatory methods, physical therapy, orthotics, orthopaedic surgery

According to the location of the CNS lesions, different disorders of muscular tonus develop such as spasticity, rigidity and hypotonia. The hypersensibility of the reflex arch due to the absence of supraspinal control is the fundamental anomaly that causes spasticity, hyperreflexia and clonus – characteristic elements of the pyramidal syndrome.

In spasticity, the answer to the rapid lengthening of the muscle is altered. Two reactions are possible:

a. A short phasic answer in "clasp knife" (intrinsic phasic spasticity),

b. A tonic answer, where the resistance to lengthening persists during the rapid passive mobilization (intrinsic tonic spasticity).

Extrinsic spasticity is the exaggeration of the spinal extrinsic reflexes in flexion or extension. Generally, spasticity predominates at the level of flexor muscles of the upper limbs and the extensor muscles of the lower limbs. In case hypertonia persists, muscle-tendon retractions may appear, which should be avoided as much as possible.

Different scales for measuring spasticity have been developed and the mostly used at present are Ashworth Scale modified by Bohannon and Smith, and Tardieu Scale.

The Modified Ashworth Scale (MAS):

0: No increase in muscle tone

1: Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension.

1+: Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the reminder (less than half) of the range of movement.

2: More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved.

3: Considerable increase in muscle tone, passive movement difficult.

4: The respective joint is rigid in flexion or extension, abduction or adduction, passive mobilization is impossible.

Tardieu Scale (intensity of the stretch reflex):

0: Without resistance during the passive movement.

1: Slight increase of resistance in the course of the passive movement, without perceiving a catch at a certain angle.

2: sudden interruption of the passive movement at a certain angle, followed by relaxation.

3: exhaustible clonus (< 10 sec. if the stretch is maintained), that appears at a certain angle.

4: inexhaustible clonus (>10 sec. if the stretch is maintained), that appears at a certain angle.

The clinical examination of the infant since birth, focusing on motor function and muscle tone, allows the specialist to assess when the threshold between physiologic spasticity and the pathological one is crossed. At the same time, one should keep in mind the fact that myelinization is cephalocaudally and proximodistally progressive.

The spinal roots myelinate earlier than the medullar central circuits and the anterior roots myelinate earlier than the posterior ones. Thus, maturation is tardier for the distal muscles (gastrocnemian, solear).

The assessment of the child must be performed periodically in order to adapt the treatment to the observed symptoms and to support the organism's adapting mechanisms (cerebral plasticity). Around the age of 5-6 years, the distribution of spasticity becomes stable and the clinical images are better outlined.

Muscle Relaxation Methods:

A. Kinesiotherapy, diminishing the reflex mechanisms.

B. Physical means of relaxation: temperature (cold or warm), electrotherapy.

C. Chemical means: alcohol infiltrations, botulinum toxin injections into the muscle belly attempt to induce depression of the gamma efferent activity on the motor end plate.

D. Medical intervention: in order to activate the inhibiting role of cortex by means of neurotrophic drugs.

E. Orthopaedic treatment.

F. Surgical treatment.

A. Kinetotherapy

Kinetotherapy represents the basic treatment method of spasticity in cerebral palsy (CP). Muscle relaxation through movement is based on manipulating certain physiologic mechanisms that inhibit the motor neurons.

In **Bobath method** this target is achieved by inhibiting reflex positions.

The inhibition of spasticity takes place:

— starting from key points:
— central point, represented by head positioning,
— mobility point – pectoral girdle
— stability point – pelvic girdle
— by slow and maintained stretch of the spastic muscle.
— by positioning or by self-inhibition.

Thus, it is the kinesiotherapist's role to fix the head, neck and then the trunk, shoulders and hips in order to obtain a redistribution of muscle tonus.

Examples of inhibiting reflex positions:

— rocking the infant in foetal position **(fig. 1).**



Fig. 1. Rocking the infant in foetal position

— using Moro or Tonic Neck (TNR) reflexes
— positioning in ventral decubitus (VD) on the Bobath ball, with lower limbs (LL) in extension, abduction and external rotation, and the feet in extension.
— using a hammock for the infant who displays an exaggerated extension of the body axis

While facilitating appropriate postures, the Bobath Method has further developed the stabilization and balance reactions, in agreement with the normal neuromotor development stages.

Kabat Method, by its techniques of alternating antagonist muscles with rhythmic stabilization, may be used to diminish the muscular spasticity. This method uses the principles of Sherington's law of reciprocal innervations and successive induction: the stronger the agonist's contraction, the higher the antagonist's relaxation.

The principle of this method is based on the use of certain proprioceptive stimuli that are complement the patient's voluntary efforts. Thus, the motor function is facilitated and the patient has a stronger contraction than he would obtain by voluntary effort alone.

Of course, the method may be used only with older children who can cooperate in the execution of these exercises with minimal resistance.

Guy Tardieu Method is based on acquiring motor skills that are indispensable for life. According to this author, relaxation is a problem of correct positioning, the vicious posture being at the origin of increased spasticity.

Vojta Method describes reflex locomotion as basis for this therapy. Inducing precise stimuli, from well-defined postures, a series of reactions and movement patterns are initiated, having the characteristics of locomotion. In this therapy, the patients do not learn how to roll, to move into upright position or to walk; instead, their brain is stimulated to "activate" the "inborn" movement pattern and to transfer it to the trunk and limb muscles.

Metayer Technique of Automated Muscle Relaxation . The relaxation of certain muscle groups is provoked by manoeuvres that allow the correction of abnormal postures, offering the proprioceptive information necessary to the correct movement.

The characteristics of this method are:

— the child will be maintained in such a way as the catch should be correlated to the child's gravity centre.
— then, the muscles or the group of muscles that are antagonist to the spastic ones are stretched slowly (**It is not the spastic muscles that are stretched!)**

By means of this method, the abnormal postures at the levels of limbs, body axes and head are corrected.

For example:

— If the extensor muscles of the hip and knee, the plantar flexors are contracted, the progressive stretching of the toe extensors, followed by stretching of the tibialis anterior, will provoke the relaxation of the antagonists.

— Then, after the relaxation of these antagonists, maintaining the stretching of toe and anterior leg extensors, will determine a triple automated flexion of the whole LL followed by a contraction of the dorsal flexors of the foot. Thus, a total relaxation of the triceps surae is obtained. **(fig. 2)**



Fig. 2. Automated relaxation of a lower limb

— The muscles of the infant's LL may relax by a passive flexion of his toes, followed by the flexion of the knees and hips. The therapist places the infant's head on her shoulder, which will decrease the paravertebral contraction? After this manoeuvre, the infant will relax entirely. **(fig. 3)**



Fig. 3. Relaxing the spastic infant

— In order to relax the thigh adductors and the hamstrings , the child is placed on the table, with his back to the therapist, slightly bent backwards, and concomitantly propping on the thigh opposed to the examined limb. Then, the triple flexion of the propping LL is executed, simultaneously with a lateral inclination of the trunk and a rotation of the body axis in order to elicit an automated antigravity reaction. The accelerated lateral inclination will permit an extension of the free LL without pain or discomfort. **(fig. 4).**



Fig. 4. Relaxing the thigh adductors and the hamstrings

— In the upper limb (UL), the pronation and cubital flexion of the hand elicits the automated relaxation of the flexor muscles of the fingers.**(fig. 5)**



Fig. 5. Relaxing the flexor muscles of the fingers

— The progressive, passive extension of the fingers elicits the relaxation of the flexor muscles of the fist, and then positioning the hand at shoulder level, (hand carrying the tray) the therapist elicits the relaxation of all UL muscles. **(fig. 6)**



Fig. 6. Finger extension (hand carrying the tray)

— The therapist will then execute an extension and a supination of the entire UL maintaining the child's fingers in extension, and with the other hand she will support his the elbow, for a complete extension of the limb. **(fig. 7)**



Fig. 7. Complete extension of the upper limb

The neurophysiologic process at the basis of these automated reactions has not been clarified yet and it is the object of present research in the field. Anyway, the angles obtained, goniometrically measured, are visibly larger after these manoeuvres.

Margaret Rood Method, by its global postural models and certain stimulations (stimulation with a brush, stimulations with ice cubes, gentle petting, vibrations), facilitates the contraction of certain muscles, inhibiting the spasticity of the antagonists. For example:

— caressing the cervix softly, in the C2-C5 zone, elicits paravertebral relaxation

— vibrations applied on peroneal malleolus produces the contraction of peroneal muscles with the result that the spastic tibialis posterior will relax

— vibrations applied on tibial malleolus activates the foot supinators and adductors while relaxing the antagonists, respectively, the peroneal muscles.

— similar effects are obtained with the vibrations applied on radial or cubital apophysis

— the rapid flexion of a limb leads to the inhibition of the flexors.

— swinging the child held by his ankles with his head downwards is relaxing, as is the swinging in foetal position.

Relaxation through muscle stretching

Muscle stretching aims at increasing joint mobility. The bond of actin-myosin myofilaments is undone by breaking the cross-bridges, thus arriving at the normal resting length of the muscle.

In children, usually a passive stretching is executed by stretching the muscle very slowly and maintaining it in this state for a while. Passive stretching may last for 10 seconds to 1 minute, repeating it in 2-5 sets with 30 seconds rest in-between.

The benefits of stretching consist in:

— increased flexibility of the tissues

— increased ability to learn different movements

— physical and psychological relaxation

— decreased muscular tension

— heating of tissues.

The child will be prepared for the stretching exercises by being exposed to a warm environment.

— the exercise start with the distal joints;

— initially, one joint is stretched, then 2–3 joints are acted upon;

— the traction will be slow, soft, along the axis, without producing pain, in order to avoid the break of myofibrils.

— the therapist should be careful with infants under 6-7 months: their knee and elbow must not be extended completely as they are in a physiologic semi flexion at this age!

In newborns, stretching is performed in good conditions on the kinesiologic table, on the Bobath ball or on the roller.

B. Physical Means

Massage

It is not recommended in the pyramidal hypertonia, which aggravates because of skin and muscular excitations. Only effleurage on the muscles antagonist to the spastic ones should be applied.

Hydrotherapy

The spastic child's immersion and exercises into warm water, besides their inhibitive effect on muscle tonus, have a beneficial psychological effect as recreation activity.

Cryotherapy

Muscle relaxation through the local use of low temperatures in medical therapy or the removal of heat from a body part is quite used frequently. However, the physio-pathological explanation still constitutes the object of certain discussions, the opinions being divided between the theories of reduction the nervous conductibility and the ones supporting the existence of certain sympathetic correlations with effect on the muscular contractility or on vasoconstriction. Finally, one could take into consideration the possibility that the low temperature would influence the degree of polymerization of the myosine molecule.

In any case, the effects of ice cube applications are evident in tricipital contracture in CP or in the case of congenital varus equine foot. Practically, a frozen bag with gel is applied on the spastic Achilles' tendon and on the inferior part of the triceps surae, it is covered with a towel, and the therapist will execute tricipital stretches for about 10 – 15 minutes. in the case of patients with spastic hemi-paresis, plantar ice stimulation will induce the contraction of plantar dorsiflexor muscles accompanied by the relaxation of the extensors.

Thermotherapy

In this case, immersions in lukewarm water or paraffin packing are used. The brushed surface should cover the spastic muscle and tendon region completely. The procedure has results similar to the case of incipient retractions; after the paraffin is applied, stretches of the respective muscle follow.

Functional Electro-Stimulation

By this procedure, groups of muscles antagonistic to the spastic ones receive electric stimulations that induce contractions. Thus, the extension movements of the fist and fingers or the dorsiflexion of the foot can be assisted. Technical parameters are: the frequency of the impulses 20-30Hz, the duration of the impulse 0,05-0,7 miliseconds, set of impulses 3 seconds, break between sets 3 seconds.

Actinotherapy

This method uses the warmth of infrared radiations for muscle relaxation.

C. Chemical Means

Infiltrations of 45°-60° alcohol in motor points used in the 60's and initiated by professor G. Tardieu, demonstrated the selective removal of the gamma spasm with the preservation of the voluntary contraction. During the last 20 years, the botulinum toxin injections have been used to block the neurotransmission presinaptically and to generate a stable state for a period of 3 – 6 months, which sometimes becomes permanent.

D. Medical intervention

It implies the gama amino-butiric acid (GABA) system, using agents that inhibit the secretion of neurotransmitters to the synapses at the level of motor neurons. Here are some of the most known drugs:

— Benzodiazepine – which reduces the hypertonia at the level of receptors from the brain stem and marrow.

— Diazepam (Valium) is the mostly used with children, starting with 1-2 mg, 2 times a day, up to a maximum of 1mg/Kg/day.

— Baclofen (Lioresal) acts at medullar level, presinaptically, as antagonist of the GABA receptors. The dose is 0.75mg/Kg P.O. In children aged from 12 months to 2 years, the sustenance dose is 10-20 mg, while in children aged 2 -10 years, it is 30-60 mg. The treatment should start with small doses in 4 fractions, gradually increasing it up to the sustenance dose. In western countries, the intrathecal administration of Baclofen is practiced by means of a pump, but only very rarely with small children, due to complications generated by the breathing depression and major hypotonia.

— Dandrolen acts as an antagonist to calcium, being used with adults and less used with children since it implies a hepatic risk.

E. Orthopaedic and Orthotic Treatment

Muscular lenghtening by means of successive plaster moulds at 2-3 week intervals, especially for triceps surae, hamstrings, fist and finger flexors. According to G. Tardieu, the number of sarcomeres decreases.

Starting with postural and vertical support installations and ending with functional orthoses for walking and positioning, the othoses are meant to prevent and correct deformities. For example: the repose or walking antiequine orthosis, anti genu flexum orthosis, hand and hand joint orthosis, etc.

The range of orthopaedic footwear is widely spread and the orthotists require precise and detailed information in order to manufacture it.

A new generation of antiequine orthosis called "Kiddie gait" may be installed inside the footwear. **(fig. 8, "Kiddie gait" orthosis a). uninstalled b). installed inside trainers)**



Fig. 8 a. Uninstalled "Kiddie gait" orthosis

Fig. 8 b. "Kiddie gait" orthosis installed inside trainers)

SWASH Orthosis (Sitting, Walking and Standing Hip Orthosis) is also a relatively new acquisition and it has proved its utility achieving

— independent flexion of the hip

— maximum abduction of the hip during flexion

— minimum abduction of the hip during extension in order to avoid LL forfecării

Thus, the risk of the rather frequent secondary coxofemoral subluxation will be avoided in children with spastic paraparesis or tetraparesis (**fig. 9a – SWASH uninstalled orthosis, fig. 9b – SWASH orthosis installed on a child, fig. 10. Radiography pelvic girdle – spastic paraparesis without orthosis, fig. 11. Radiography pelvic girdle – spastic paraparesis with orthosis).**



Fig. 9 a. SWASH uninstalled orthosis



Fig. 9 b. SWASH orthosis installed on a child



Fig. 10. Radiography of pelvic girdle – spastic paraparesis without orthosis

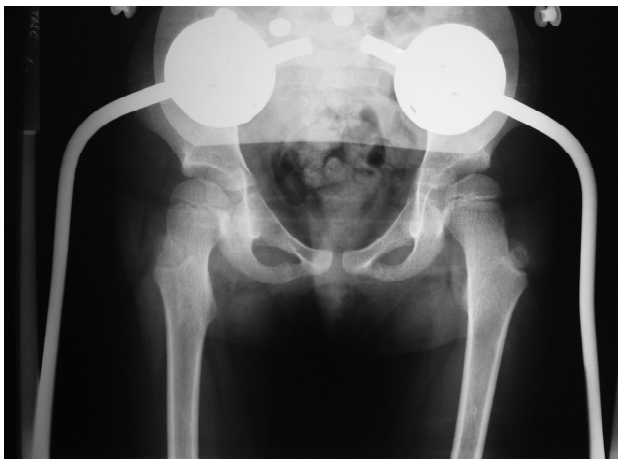


Fig. 11. Radiography with SWASH orthosis

The newest acquisition in the field of orthoses is the sensorial dynamic orthosis, a dynamic compressive costume, designed to assure a constant sensory feedback by means of pressure and resistance. A better motor scheme and a postural rebalance are facilitated. The orthosis is manufactured after detailed measurement either of the limbs or of the trunk and limbs. **(fig. 12 - Sensorial dynamic orthosis for the trunk, fig 13 - Sensorial dynamic orthosis for the UL)**



Fig. 12. Sensorial dynamic orthosis for the trunk



Fig. 13. Sensorial dynamic orthosis for the UL

Posture control is ameliorated, the quality of UL function, of the sitting and upright postures and of the walking has increased**. (Fig.14 a - spastic paraparesis – sitting without orthosis Fig. 14 b sitting without orthosis, Fig 15 a spastic hemiparesis – the position of the hand without orthosis, Fig. 15 b spastic hemiparesis – the position of the hand with orthosis).**



Fig. 14 a. Spastic paraparesis – sitting without orthosis



Fig. 14 b. Sitting without orthosis



Fig 15 a. Spastic hemiparesis – the position of the hand without orthosis



Fig. 15 b. Spastic hemiparesis – the position of the hand with orthosis

The orthosis is worn 10 -15 minutes, in the beginning, increasing gradually the period until 6-8 hours.

E. Rehabilitating Orthopaedic Surgery

This kind of surgery may be corrective or functional and ameliorates the spastic patient's condition when the physiologic and orthopaedic means proved to be inefficient. One should keep in mind that the moment of intervention needs to be chosen carefully, some surgery cannot be performed before a certain age (the ossification of certain nuclei). Then, the functional potential of the child, his intellectual development, real bone age and general condition must be assessed correctly.

Along the years, the frequency of deformity relapses in children with CP have determined specialists to exaggerate, at a certain moment, with tenotomies and tendon lengthening, which sometimes provoked the inversion of some deformities, more severe than the initial ones. For example, the lengthening of Achilles' tendon resulted in a clubfoot, and the intervention on the hamstrings resulted in an uncomfortable genu recurvatum.

At a certain moment, another type of intervention, the Partial Sensitive Rhyzotomy, had many adepts, especially among the American surgeons. However, the access to the posterior nerve roots implies posterior laminectomy. At a diplegic patient, this intervention is performed on 4 vertebrae and 2 ribs with partial sectioning of the last three lumbar roots and the first two sacral ones.

The postsurgical functional regress is of 6 months to 1 year and secondary rachidial deformities may develop, too. This type of intervention must be estimated very thoroughly because there is also spasticity that is useful for posture stability and co-contractions indispensable for joint stability.

In the international specialist literature there are certain doubts concerning the recommendation of sensitive rhizotomy, due to the lack of convincing controlled research.

The CP surgical treatment has changed a lot lately. The botulinum toxin, Baclofen pump, successive plasters, gait analysis, kinesiotherapy, have diminished the recommendations for neurotomy and neurectomy, which had been used rather frequently in the past. Percutaneous surgery, the improvement of the techniques have also allowed a shortening of the immobilization period and the optimization of the results.

The interdisciplinary examination should decide on the most favourable moment for a surgical intervention, on the best technique as well as on the rehabilitation following surgery. The surgical act is never the limit. It is followed by intense functional rehabilitation, which reinforces the surgeon's achievement.

In conclusion, muscle relaxation in CP is highly important because spasticity

— generates an abnormal function of the respective segment.

— maintains a vicious circle of phenomena, which prevent the improvement of the patient's motor function.

— produces deformities.

— **slows down the normal process of rehabilitation.**

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