pISSN 2349-3283 | eISSN 2349-3291

Original Research Article

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20172657

Efficacy of sub-occipital muscles decompression techniques in restoring functional walking capacity in hemiplegic cerebral palsy children

Ahmed M. Azam*

Department of Physiotherapy for Developmental Disturbance and Pediatric Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt

Received: 02 May 2017 Accepted: 10 June 2017

*Correspondence: Dr. Ahmed M. Azam,

E-mail: prof.ahmedazzam@yahoo.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: This work was carried out to investigate the efficacy of sub-occipital muscles decompression in restoring functional walking capacity in hemiplegic cerebral palsy children.

Methods: Thirty children were enrolled in this study and randomly assigned into two groups; group A (sub-occipital muscles decompression techniques plus traditional physiotherapy program) and group B (Traditional physiotherapy program only). 6 minutes walking test (6MWT) was used to quantify, evaluate and follow functional walking capacity also flexibility tests were used to detect and follow hamestring and calf muscles elasticity. This measurement was taken before treatment and after 12 weeks of treatment for all patients. The children parents in both groups A and B were instructed to complete 3 hours of home routine program.

Results: Data analysis was available on the 30 hemiplegic cerebral palsy children participated in the study. No significant difference was recorded between the mean values of all parameter of the two groups before treatment. By comparison of the two groups 'results after treatment there was significant improvement in functional walking capacity in favor of the study group. The difference between pre-and post-treatment results of each group was

Conclusions: According to the results of this study supported by the relevant literature it can be concluded that the combined effect of physiotherapy training program in addition to sub-occipital muscles decompression techniques can be recommended in restoring functional walking capacity in hemiplegic cerebral palsy children.

Keywords: Functional walking capacity, Hemiplegic cerebral palsy, Sub-occipital muscles decompression

INTRODUCTION

The sub occipital muscles are comprised of eight muscles total (one set of four on either side). The upper cervical spine has been shown to be the most concentrated area of mechano-receptors (joint position receptors) in the body. The sub occipital muscles have been also shown to have a very dense number of muscle spindle cells and GTOs (Golgi tendon organs) monitoring joint position as it relates to the muscle.1 A crucial area of the myofascial meridian called the Superficial Back Line (SBL) is a

ribbon of facial and muscular continuity that begins with the plantar fascia and short toe flexors beneath the arches of the foot, wrapping around the heel to the soleus and gastrocnemii of the lower leg. The gastrocs interlock with the hamstrings, which are in turn continuous with the sacrotuberous ligament, which feeds into the sacral fascia. The sacral fascia is the fascial anchor for the back muscles that traverse the spine, and it is the very top muscles of this group to which we will turn our attention in this column. The SBL, however, continues on beyond the occipital ridge, up along the top of the skull with the epicranial fascia, including both the occipitalis and frontalis muscles, until it attaches at its other end, the brow ridge just above the eye socket.²

Rectus capitis posterior minor has been noted to have a fascial bridge into our dura mater (the outer layer of the meninges which surrounds our spinal cord and brain). A potential role that rectus capitis posterior minor is to try and regulate dural folding, or movement of dura towards the spinal cord which occurs during head extension. It has been inferred that individuals may experience muscle tension, headaches and pain when the rectus capitis posterior minor muscle acts inappropriately on dura.³

The fascial system is important not only because it can passively distribute tension in the body muscles when mechanically stimulated, but also because it contains mechanoreceptors and possesses an autonomous contractile ability that influences the tension of the fasciae. The stimulation of intrafascial mechanoreceptors (mostly interstitial and Ruffini endings) causes the vegetative nervous system and the CNS to change the tension in intrafascial myofibroblasts and regulate fascial pre-tension. These tensions are transmitted along the MFC (myofascial chains), thereby influencing the posture of the entire body.⁴

Connective tissue bridges were noted at the atlanto-occipital joint between the rectus capitis posterior minor muscle and spinal dural matter. The perpendicular arrangement of these fibers appears to restrict dura matter movment toward spinal cord. The ligamentum nuchea was found to be continous with posterior cervical spinal dura and lateral portion of the occipital bone. The dural-muscular and the dural ligamentous connection in upper cervical spine and occipital area provide anatomic and physiologic answers to cause tension regulation. Nuchal-dural-adhesion theory stated that Increased tension within sub-occipital muscles may produce abnormal traction on the cranial dura stimulating dural nociceptive fibers leading to tension changes.⁵

METHODS

Thirty children from both sexes with hemiplegic cerebral palsy children were enrolled for this study, aged 8 to 12 years at time of recruitment because the children in this age are able to participate in functional walking capacity test, children are able to walk without assistance with an abnormal slow gait. Children who otherwise met the inclusion criteria were excluded if they had: previous BoNT-A injections in the lower limb in the past 12 months or prior lower limb surgery (i.e. tendon transfer/tendonlengthening).

Children were randomized to the experimental group A (sub-occipital muscles decompression techniques plus traditional physiotherapy program) and group B (Traditional physiotherapy program only). The treatment session of 45 to 60 minutes was conducted. The treatment

was continued for 6 consecutive days for 12 week's session in physiotherapy treatment room. Group (A). children in the experimental group were exposed to sub-occipital muscles decompression techniques maintained for 8 minutes until tissue relaxation had been achieved plus traditional physiotherapy program. During the SMI technique, the subject is asked to keep his eyes closed to avoid eye movements affecting the sub-occipital muscle tone. Home routine program 3 hours daily for the 12-week treatment period. Control group (B) received a traditional physiotherapy program only.

Outcome measurements

Six-minute walk test (6MWT)

We assessed functional walking capacity with the sixminute walk test (6MWT) The most common measure used to quantify functional walking capacity, a task that requires walking speed and balance and sub maximal endurance. These are the necessary components for CP community-dwelling children with to independently. The primary outcome (dependent) variable was functional walking capacity, evaluated using the 6MWT. The variable under study (exposure or independent variable) were sub-occipital muscles decompression techniques plus traditional physiotherapy program, 6MWT assesses the objective functional capacity by making a person walk for defined period of time and measuring distance covered and it is better than the self-report for assessing functional capacity. The 6MWT is easy to administer, better tolerated, and more reflective of activities of daily living than the other walk tests.⁶ The 6MWT evaluates the capacity to maintain a moderate level of activity over a time period, reflective of activities of daily living that are performed at a submaximal level of exertion. We asked participants to walk as fast as they could for 6 minutes to cover as much distance as possible along a 15m corridor. If needed, the participants were allowed to rest but had to continue walking as soon as possible.6

Flexibility test of the lower limb muscles (hamestring and calf muscles)

- Flexibility test for calf muscles
- Forward flexion distance test for hamstring flexibility test.

The subject is standing on the box, now ask the subject to perform a maximum and progressive anterior flexion of the trunk, maintaining the knees straight and lengthening the arms with the palms parallel and the fingers extended. The measuring tape is used to determine the distance from the distal part of the fingers to the top of the box.

Intervention

Both groups (A and B) received a traditional physiotherapy program, as the following:

- Hot packs to improve circulation and relax muscle tension applied on the hamstring and calf muscles for 20 minutes.
- Facilitation of anti-spastic muscles (quadriceps and anterior tibial muscles): tapping at the muscles followed by movement, quick stretch, triggering mass flexion, biofeedback, weight bearing, compression on bony prominence, approximation, vibration, irradiation to weak muscles by strong muscles, and ice application for brief time.
- Prolonged stretch to L.L muscles to gain relaxation as positioning, night splint and reflex inhibiting pattern for 20 minutes.
- Slow Passive stretching of the tight muscles (hamstring, calf muscles, hip flexors and hip adductors) to regain mobility of the muscles and sheath. It must be slow, gentle and gradual lasting 20 second then relaxation 20 second repeated 3-5 times per session then maintain the new range by using adjustable knee and ankle splint after the session for two hours then release for gait training and ADL activity.
- Graduated active exercise for lower limb muscles with special emphasis on quadriceps and ant. tibial group
- Gait training using aids in closed environment using obstacles side walking
- Balance training program which include static and dynamic training.
- Faradic stimulation for the ant. tibial and quadriceps to modulate muscle tone. Calf muscles should be fully stretched to prevent cross electricity to reach calf muscles because these spastic muscles are more sensitive to electric stimulation than anti-spastic muscles. The Mother was asked to support ankle in dorsiflexion during electrical stimulation for 15 minutes.
- Faradic stimulation for wrist extensors to improve their efficiency and inhibit spastic wrist flexors by reciprocal inhibition.

The experimental group (group A) received specialized training program as the following

Sub occipital muscles inhibition techniques

There are several safe treatment options for the sub occipital muscles inhibition:

- Trigger point technique (2 minutes)
- Reciprocal inhibition technique (2 minutes)
- Pressure technique (2 minutes)
- Cervical isometrics contract relax technique (2 minutes).

Trigger point technique

Applying compression or friction to these muscles can be done so at the base of the occiput and even on the posterior tubercle of C1 and the spinous process of C2. When you find trigger points that are referring their common pattern (up into the head and behind the eyes) just hold that point for 2 minutes until the referral dissipates, and then move on to investigate the tissue next to it, keeping in mind that trigger points often form in clusters.⁷

Reciprocal inhibition technique

A good way to do this is to place one hand behind the head of the supine children, and then other hand on top of their forehead. This will help you move the head into flexion, stretching the sub occipitals, without getting too much contribution from the lower spine (C3-7). Additionally, in some acute situations, where there is pain upon isometric contraction (extension) of the sub occipitals, you can try and have the child contract the deep neck flexors (nodding their chin towards their Adam's apple and placing an isometric contraction into your hand which is on their forehead) to try and allow the sub occipitals to relax via reciprocal inhibition before taking them to their next stretch barrier.⁷

Pressure was exerted upward and toward the therapist

With the child supine, the therapist sat at the head of the table and places the palms of hands under the subject's head, pads of therapist's fingers on the projection of the posterior arch of the atlas which is palpated between the external occipital protuberance and spinous process of axis vertebra. The therapist locates with the middle and ring fingers of both hands the space between the occipital condyles and the spinal process of the second cervical vertebra. Then, with the metacarpophalangeal joints in 90° flexion, therapist rests the base of the skull on hands. Pressure was exerted upward and toward the therapist.⁷

Cervical isometrics contract relax technique

Treating the tight muscles for increasing length such as local site stretching techniques. cervical spine treatment that might produce an increase in joint range of motion and tight muscles extensibility. The change in the extensibility of muscle following application of cervical isometrics contract relax technique via using isometric contraction of neck extensors with chin in toward the chest. significant increase in remote joint range of motion due to generalized inhibition.⁷

RESULTS

Patients characteristics

Table 1 shows the demographic and clinical characteristics of all patients. There were 12 boys (40%) and 18 girls (60%), and in term of Right hand dominance reported in 14 patients (46,66%), and also 16 patients (53.33%) were left hand dominance. There was no significant difference between the two groups in terms of

age (p= 0.4079), in term of sex (p= 1.0000) and in term of hand dominances (p= 0.4814).

Table 1: Patients' characteristics.

Variables	Study group n=15	Control group n=15	P- value	
Age sex n%	10.000±1.46	9.60±1.12	0.4079	
Boys	6 (40%)	6 (40%)	1.0000	
Girls	9 (60%)	9 (60%)		
Hand dominance n%				
Right	8 (53.33%)	6 (40%)	0.4814	
Left	7 (46.66%%)	9 (60%)		

Changes in functional walking capacity

Mean test scores and standard deviations for both groups are shown in the Table 2. The mean value of functional walking capacity level in both groups (assessed by 6 minutes' walk test) at baseline measurement (pretreatment) was insignificant (p>0.05). while both groups had a significant improvement in functional walking capacity post-treatment (p <0.05). The average improvement of functional gait capacity level tended to be highly significant in the study group (43.87±2.59) versus (45. 8±3.71), p= 0.0015 than in the control group (43.87±2.50) versus (44.67±2.50), p=0.0281. The percentage of improvement of functional walking capacity level was (4.399%) in the study group compared to the (1.823%) in control group.

Table 2: The average test of functional walking capacity in both groups.

Functional walking capacity level	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	43.87±2.59	43.87 ± 2.50	1.0000
Post-treatment	45.8±3.71	44.67±2.50	0.3412
Improvement%	4.399	1.823	0.0038
P-value (within groups)	0.0015	0.0281	

DISCUSSION

The basic element of the correlation between small suboccipital muscles and human posture is the existence of muscle-fascial chains (MFC). Fasciae are dense, fibrous connective tissues that interpenetrate and surround the human body to protect, nourish and hold organs in place. Three layers of fasciae exist: superficial, deep and visceral. Deep fasciae surround muscles, bones, nerves and blood vessels and is densely populated with myofibroblasts and several types of receptors (nociceptors, proprioceptors, mechanoreceptors, chemoreceptors, thermoreceptors). Myofibroblasts are fascial cells that are created as a response to mechanical stress and actively contract in a smooth, muscle-like manner.8 The fact that The SMI technique (sub occipital muscles inhibition technique) could increase the flexibility of the LL muscles may be because the superficial back line was relaxed through relaxation of the sub occipital muscles. The sub occipital muscles are the "proprioceptor monitors" that contribute significantly to regulation of head posture, and they have the most muscle spindles in the human body. Among them, in particular, the rectus capitis posterior minor muscle, which has 36 muscle spindles per gram, is known to contribute greatly to regulation of posture and the degree of tension.⁹

Indication of sub-occipital muscle inhibition (SMI) technique in pediatric

- In dealing with C.P with extremely tight muscles, that attempting to stretch and inhibit them without pain,
- Or passive stretch to tight muscles is not possible due to presence of intermedullary nails or plate and screw or in plaster cast
- Or to avoid forced passive stretch which may lead to muscle strain.
- During times of injury or after surgical release, when it would not be advised to passively take the tight muscles through a stretch.¹⁰

Underlying mechanism of sub occipital muscles inhibition and restoration of functional gait capacity

The SMI technique is a method of inducing relaxation of the fascia by applying different approaches to the sub occipital area of the patient while child is lying comfortably, and it can be easily applied by a therapist. Increase in calf and hamstring elasticity occur due to the presence of Myodural Bridge connecting rectus capitis posterior minor muscles to the duramater which produce generalized inhibition to the lower limb muscles. Therefore, the SMI technique to the sub occipital area and compared the effects on the flexibility of the calf, hamstring muscles and functional walking capacity.

There are several hypotheses for the positive result of this treatment

- The connection to dura mater: This plays to the continuity of the nervous system and how it links everything together.
- Postural control: The sub occipitals play a role in postural control and will affect the coordinated movement of muscles down the chain.
- Myofascial chains: Both the sub occipitals and the hamstring and calf musculature are included in the superficial back line. Addressing any of the structures in the superficial back line may have a positive effect of the entire line itself.¹¹

Rectus capitis posterior minor is directly linked to the dura mater in the atlanto-occipital joint region. However, the authors likewise demonstrated that pressure applied intra-operatively on the posterior zone of the dura mater triggers pain in the sub occipital region. Since the myodural bridge has a direct influence on the pain-sensitive dura mater, a possible link between cervical muscles and headaches in addition to muscular tension is postulated. On the basis of these findings, it may be hypothesized that the bridge between rectus capitis minor und dura mater is stretched in a whiplash trauma, which would explain the chronic symptoms of such patients.¹²

Attachments of the ligamentum nuchae to the dura mater as well as to the posterolateral part of the occipital bone. There is anatomical relation between rectus capitis posterior minor and dura mater. Dural vascular irritation leads to activation of the neck and jaw muscles; clinically, this points towards a relation to headaches and facial neuralgia. hypertonicity of the rectus capitis posterior minor causes permanent tension of the dura mater. this entails irritation of the meningeal vascular systems and, in due course, hyperactivity of the jaw and neck muscles. Thus, improving the tone of the rectus capitis posterior minor may normalize dural blood flow and hence the tone of the jaw and neck muscles. ¹³

Clinical significance of small sub-occipital muscles with high spindle density

Kinesthetic information from the sub-occipital muscles may be handled in more complex ways, as evidenced by convergence of vestibular, oculomotor, visual and neck proprioceptive inputs at various levels of neuroaxis

- Proprioceptive inputs from the cervical musculature are important in headeye co-ordination and postural orientation.
- The sub-occipital muscles in humans have an extremely high spindle content
- Altering the afferent input from the upper cervical region can result in disturbances of gait, dizziness, loss of balance, ataxia, etc
- (Known causes of altering the afferent input from the upper cervical region include whiplash injuries, altered cervical blood flow, and disturbances of cervical sympathetic tone.
- Cervical proprioceptive afferent inputs, vestibular afferent inputs
- (labyrinthine), and afferent inputs from the extra ocular muscles converge at the vestibular nuclei and affect the thalamus and the cerebral cortex.
- The muscle spindles of the cervical per vertebral muscles are the major proprioceptors of the neck, not the joint capsules.
- Other muscles with high spindle density are found in the hand and foot.
- Human sub occipital muscles have an extreme high spindle density, far greater than 50-100/gm, and far greater than other human muscles.
- The highest spindle density is in the inferior oblique muscle which crosses atlanto-axial joint and handles the greatest proprioceptive input.

- The proprioceptive input from the sub-occipital joints is from sensing joint position and movements of craniovertebral joints.
- (Most importantly, sub-occipital muscles proprioceptive input (along with vestibular organ and oculomotor afferent input) do much more than monosynaptic excitation of alpha-motorneurons. They send afferent input that integrates at numerous regions of the neuroaxis, including the vestibular nucleus, visual relays in the mesencephalon (where the periaqueductal gray lives), the thalamus, and the cortex.¹

A common site of tightness, in this CP children, is the gastrocnemius and soleus complex (the calf) contributing to abnormal foot mechanics during stance phase of gait. The tightness of the calf musculature in CP children results, in most cases, in equinus gait. This posture of the foot interferes with the first heel contact with the ground, thus disrupting controlled forward progression during stance phase. Equinus gait eliminates the normal foot mechanics. The tightness of gastrocnemius-soleus complex influences the relative movement of the foot and knee in the stance phase of gait. The goal of that suboccipital muscles decompression techniques is to provide a sufficient dorsi-flexion allowing for normal "heel to toe" progression via inhibit and relax the gastrocnemiussoleus complex with the aim of restoring functional walking capacity.12

Children with spastic hemiplegic cerebral palsy had a longer gait cycle, slower walking speed, and longer support phase than did healthy children. The support phase was longer than the swing phase in children with spastic hemiplegic cerebral palsy. There were significant differences in the angles of the hip, knee, and ankle joint between children with spastic hemiplegic cerebral palsy and healthy children at the moment of touching the ground and buffering, and during pedal extension. Children with spastic hemiplegic cerebral palsy had poor motor coordination during walking, which resulted in a short stride, high stride frequency to maintain speed, more obvious swing, and poor stability. ¹⁰

Increasing force production of the ant. tibial and quadriceps femoris muscles in these children as a result of calf and hamstring relaxation with decreasd prolnged stretch on ant. tibial and quadriceps muscles from tight calf and hamstring appeared to produce spontaneous improvements in their gait. In the children with lack of functional walking capacity, their lack of selective motor control may have interfered with their ability to utilize these muscles for functional activities. More effective remediation of the motor deficits seen in CP must address motor control problems as well as static contractures.⁷

CONCLUSION

This study implies that sub-occipital muscle inhibition technique can be used to restore functional walking

capacity in hemiplegic cerebral palsy children by distribute the inhibition effect to tight muscles in lower limb muscles via muscle-fascial chains in order to avoid aggravation of pain caused by peripheral passive stretching of tight muscle leading to improve functional walking abilities.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

REFERENCES

- 1. Turner D, Gossman RM, Nicholson CG and Lemons J. Comparison of cyclic and sustained passive stretching using a mechanical device to increase resting length of hamstring muscles. Physical Therapy. 1988;69:314-20.
- 2. Spernoga SG, Uhl T, Arnold BL. Duration of maintained hamstring flexibility after a one- time modified hold- relax stretching protocol. J Athletic Training. 2001;36:44-8.
- 3. Waseem M, Inhumane S, Ram CS. Efficacy of muscle energy technique on hamstring muscles flexibility in normal Indian collegiate males. Calicut Med J. 2009;7:4.
- 4. Robert Schleip. How upper neck muscles influence hamstring length. J bodywork movement therapies. J Manipulative Physiologic Therap. 1997;20:443-7.
- 5. Aderonke O, Bakere U, Adegoke BOA. Influence of age on hamstring tightness in apparently healthy Nigerians. J Nig Soc Physiother. 2005;15:35-41.
- 6. Kendall FP, McCreary Ek, Provance PG, Rodgers MM, Romani WA. Muscles. Testing and Function with Posture and Pain. Lippincott, Williams and Wilkins. 5th ed; 2005.

- Chaitow L, DeLany J. clinical application of neuromuscular techniques the upper body. Churchill Livingstone; 2000:1.
- 8. McPartland JM, Brodeur RR. Rectus capitis posterior minor: a small but important suboccipital muscle. J Body Work and Movement Therapy. 1999;3(1):30-5.
- 9. Rae PS, Waddell G, Venner RM. A simple technique for measuring spinal flexion: its use in orthopedic practice. J R Coll Surg Edinb. 1984;29: 281-4.
- Schlelp R. Rolting and the neuro-myofascial net. Boulder: Rolflines; 1996.
- 11. Aparicio EQ, Quirante LB, Blanco CR, Sendin FA. Immediate effects of the suboccipital muscle inhibition technique in subjects with short hamstring syndrome. J Manipulative Physiol Ther. 2009;32(4):262-9.
- 12. Strauss D, Brooks J, RosenB R, Shavelle R. Life Expectancy in cerebral palsy: an update. Dev Med Child Neurol. 2008;50:487-93.
- 13. Van ZB, Miller M, Russo R, MurchL S, Crotty MM. Activities of daily living in children with hemiplegic cerebral palsy: a cross-sectional evaluation using the Assessment of Motor and Process Skills. Dev Med Child Neurol. 2006;48(9):723-7.

Cite this article as: Azam AM. Efficacy of sub-occipital muscles decompression techniques in restoring functional walking capacity in hemiplegic cerebral palsy children. Int J Contemp Pediatr 2017;4: 1132-7.