Effect of Tonal Abnormality On Physiological Cost Index In Patients With Cerebral Palsy

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Abstract :

Background: Children with cerebral palsy (CP) have limited functional level due to primary and secondary functional impairments like movement difficulty, problem with balance and coordination. Physiological Cost Index (PCI) is a reliable clinical tool for measuring energy expenditure during walking. However presence of tonal abnormality may affect the PCI and subsequently the energy expenditure. **Aim:** To investigate the effect of tonal abnormality in lower limb muscles on PCI patients with CP. **Methodology:** After obtaining Institutional Ethical Committee approval, ambulatory patients with cerebral palsy were included with their parent consent. Patients were asked to walk a pathway of 50 meters with or without orthosis as a self-selected speed. Along with the demographic data, type of Tonal abnormality, muscles involved, Resting & Walking Heat Rate, Walking Speed & PCI were recorded. Spasticity in lower limb muscles was assessed with the help of Modified Tardieu scale. **Result:** In the present study, out of 30 patients there were 16 boys and 14 girls in the age group of 6-12 years. Patient were divided into 3 groups on the presence of spasticity in either Tendo Achilles(TA), Hamstring(H), and in both the muscle (TA+H). There was no significant difference among three groups for the parameters – Resting Heart Rate (RHR), Walking Heart Rate (WHR), Walking speed, Physiological Cost Index. (P value for RHR 0.4724, WHR-0.8936, WALKING SPEED-0.3379, PCI -0.4952). **Conclusion:** It is concluded from study that tonal abnormality in various muscle group does not affect Physiological Cost Index.

Key words: Cerebral Palsy, Resting Heart Rate, Walking Heart Rate, Walking Velocity, PCI, Tardieu scale, Pulse oximeter.

Introduction:

CP is a group of permanent disorders of development of movement and posture causing activity limitations, attributed to non-progressive disturbances that occurred in the developing foetal or infant brain.[1-3]

Common motor impairments in CP children include spasticity, stiffness, co-contraction, weakness, decreased rate of force development, decreased power, and many others.[4-6]

Due to these impairments at the body structure and function level, the activity of walking is often compromised in children with CP, which restricts their participation by negatively affecting their health and their ability to keep up with their peers.[7]

Children with spastic CP have strictly individual gait with numerous variations, which is also characterised by increased tonus and hyperflexion of the muscles.[8] Muscle weakness is also a significant impairment in children with CP and muscle strength has been shown to be highly co-related to gait speed and locomotor ability.[9,10] Normal walking requires balance, propulsion, shock absorption and energy consumption. CP children affect these factors because of tone abnormality, altered muscle performance and posture abnormality.[11] Because of all these factors present in CP children, there is increase energy expenditure in these children. So, energy expenditure is important measure for more efficient functional evaluation & effectiveness of intervention. Energy expenditure occur and oxygen consumption is closely related to energy expenditure.[12] Physiological Cost Index (PCI) is used for measuring the energy expenditure of walking. There is a linear relationship between Heart Rate (HR) and oxygen uptake.[12] There are various researches done on children with cerebral palsy for measuring cost of energy expenditure. But there is paucity of researches focusing on spastic component affecting cost of energy expenditure. Hence spasticity is one of the important factor need to be considered while measuring Physiological cost index. So, the purpose of this study is to measure physiological cost index in children with CP who has lower limb tonal abnormality.

Methodology:

This cross-sectional study was carried out in Physiotherapy department of tertiary care hospital, Ahmednagar, India. 30 patients with diagnosis of Cerebral Palsy were included in the study. The inclusion criteria was the patients in the age range of 6-12 years with lower limb tonal abnormality [including those who use walker or Ankle Foot Orthosis (AFO)], ability to walk 50 meter distance. Patients unable to walk with or without assistance, children with quadriplegia, surgery/ Botox in last 6 month or any other neurological condition were excluded from the study.

The aim and procedures of the study were explained to mother of child, following that a written informed consent was obtained from parents before commencing the study. Demographic data of the patients was recorded. Tone of lower extremity muscles i.e. Tendo Achilles and Hamstring was checked with the help of Modified Tardieu Scale (MTS). Baseline parameter of Resting Heart rate was measured and pulse oximeter was put on child's index finger.

Then the patient was asked to walk for 50 meters at self-selected speed. Time required for completion of the task was recoded. After completion of task (in last 10 meters), Walking Heart Rate was measured and walking speed was calculated. The procedure was repeated two more times after a brief rest period and three reading were recorded. PCI was calculated using the formula. Mean of three reading was taken for final analysis.

Formula for calculation of PCI is PCI (beats/min)= Walking Heart Rate- Resting heart Rate / walking speed (m/min).

Result:

In the present study out of 30 subject there were 16 boys and 14 girls in the age range of 6-12. Out of these, 16 children had spasticity in Tendo Achilles muscle, 6 children had spasticity in hamstring muscle , 8 children had spasticity in both muscles. 3 patients had grade II spasticity whereas rest of them had grade I spasticity according to Modified Tardieu Scale.

A comparison was made between Resting Heart Rate, Walking Heart Rate, Walking Speed and PCI in all three groups viz patients with spasticity only in Tendo Achillis (TA), Hamstring (HAMS) and in both muscle groups (TA/HAMS). One Way ANOVA test was used to compare means of three groups.

Table 1: comparison of mean of parameters of three groups TA/HAMS/TA-HAMS

PARAMETERS	TA Mean± SD	HAMS Mean± SD	TA/HAMS Mean± SD	One way ANOVA (P value)	Result
RHR	81.5±10.2	80.9±13.6	81.3±6.5	0.4724	Not significant
WHR	90.4±13.5	91.2±17.1	90.6±11.1	0.8936	Not significant
WALKING SPEED	36.6±15.7	33.3±17.4	35.5±14.6	0.3379	Not significant
PCI	0,25±12.6	0.33±1.5	0.25±1.5	0.4952	Not significant

There is no significant difference among three groups for the parameters – Resting Heart Rate, Walking Heart Rate, Walking speed, Physiological Cost Index.

Discussion:

Out of 30 children, 21 children were able to walk without orthosis and 9 were able to walk with orthosis. Among 30 children, 3 walked with walker,1 walked with crutches, rest of children without walking devices. There was no significance difference between in physiological cost index among three groups.

Walking speed was considerably reduced in children with CP as compare to normal children.[3,13,14] One of the factors responsible for this can be increased tone in one group of muscle which does not allow relaxation of opposite group and hence extra efforts is required to perform the same task more. AFOs helps in progress of the gait of an individual patient, but may not be useful in other children with CP. AFO usage endorsed a more pendular gait pattern which allow better energy recovery, the amplified work of extended steps (increased energy variation) meant that the work per meter on the COM fixed.[11,12]

There was no significant difference between resting heart rate and walking heart rate among three groups, so also mean PCI was similar in all three groups. This suggest that spasticity in one group or more than one group does not necessarily increase the energy expenditure. This may probably be due to mild spasticity in these muscle groups. Hence, a future study can be conducted on patients with severe spasticity. Also patients with and without assistive device were included in the present study. This might have masked the effect.

The children with CP performed double mechanical work on their COM compare to typically growing children as in both a greater vertical excursion of their COM and a lesser phasic association between their kinetic and potential energies.[15,16] In children with hemiplegic CP a there is poor pattern of exchange between potential and kinetic energy of the HAT (head, arms, torso) segment contributed to high total energy costs.[17-19]

However there were few limitation in study. The number subjects in each group were not equivalent. Also the extent of spasticity as measured by Modified Tardieu Scale was not similar in all groups. Use of pulse oximeter in children who need either a walker or cane for ambulation is sometimes not feasible as children find it cumbersome to wear pulse oximeter in the finger and use the walking device with the same hand.

Conclusion:

It is concluded from study that tonal abnormality in various muscle group does not affect physiological cost index.

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