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Comparison of chest expansion in CP Diplegic Children with age-matched normal children

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Abstract
Study objective: To compare chest expansion in CP diplegic children with age-matched normal children.
Materials and Methods: 50 subjects (25 CP diplegic and 25 age-matched normal children) were enrolled in the study, age group of subjects was 5 yrs to 15 yrs. Chest expansion was measured for each child at three different levels and data obtained from both the groups was analyzed.
Design: observational study.
Conclusion: Chest expansion in CP diplegic is less as compare to that of normal counterpart.

Keywords: chest expansion, diplegic children, age-matched

Introduction

Cerebral palsy is a term used to describe a broad spectrum of motor disability which is non - progressive & is caused by damage to brain at/or around birth. It is a disorder which develops due to damage to CNS and this damage can take place before, during or immediately after birth of the child [1]. Incidence rate is 3 / 1000 live births [2].

Clinically, movement-related disorder have traditionally been classified according to type of muscle tone abnormalities i.e. spastic, athetoid and ataxic type and involved limb i.e. hemiplegic, diplegic, and quadriplegic type [3]. In spastic type, the spasticity seen in cerebral palsy is usually clasp knife, these children also show certain abnormal posture. These postures are as a result of spastic muscle group.

In athetoid CP children exhibits slow, purposeless, wormlike, involuntary movement which flow into each other. In ataxic CP there is damage to the cerebellum. Thus both balance and coordination are affected [1].

In normal child the respiratory system develops as in upper airways the larynx lies higher in neck, glottis is located between C3 - C4 and it is funnel - shaped. Epiglottis of an infant is larger and less flexible. The trachea is 5 - 6 cm long and 4mm in diameter approx. In lower airways the development of alveoli is 480 million approximately & formation of septa in terminal airways. By adulthood, the alveolar capillary membrane has a gas exchange surface area of 140 meters approx. In infants the thoracic cage is more Box - like, with the ribs being horizontally oriented, in addition the diaphragm inserts into the thoracic cage in horizontal position. As the child grows the ribs take a progressive downward slope and rib cage configuration seen in adults. Ossification of ribs & sternum is normally completed by 25yrs of age and this combined with muscular development, results in stiff chest wall that moves more in the A-P Dimension with inspiratory effort. There is increased in lung volume by trapping gas which improves V/Q matching and gas exchange [4].

The development in CP child is always delayed [4]. Child with CP has a lower activity level than normal child because of which the child is unable to perform activities in a manner that cause deep breathing. Thus muscle activity in CP children is lower than that of a normal child which affects lung compliance of the CP child [5]. Child with CP often present with serious lung conditions like Broncho pulmonary dysplasia & RDS [6, 7]. There is chronic or recurrent respiratory problems in children with CP which have an impact on their quality of life and life expectancy.

Some of the causes include

1. Risk of aspiration.

2. Insufficient cough.
3. Upper airways obstruction.
4. Progressive Kyphoscoliosis [7, 18].

There are some studies which shows that the truncal expansion and respiratory functions are more affected in Hemiplegic CP as compare to Diplegic CP [8].
Out of which spastic hemiplegic and diplegic are ambulatory and quadriplegics are non ambulatory.
Diplegia is the most common form of spastic cp [9] A white mater infract in the periventricular areas caused by hypoxia can lead to spastic diplegic cp [9]. It primarily affects bilateral lower extremities, resulting in issues with gait balance and coordination. There is a discrepancy between upper extremity and lower extremity function in children with diplegic cp with lower extremity being more affected than the upper extremity and trunk. Owing to bilateral lower extremity spasticity and weakness, energy expenditure is much greater during ambulation, resulting in poor endurance and decrease functional mobility at home and within the community [9].
CP diplegic children suffer from respiratory infections quite often they have risk of aspiration, insufficient cough and upper airway obstruction.
All these could be affected by insufficient oxygenation which could be because of limited expansion of the chest. So there is a need to evaluate whether chest expansion is affected in these children or not.

Materials and Methods

25 diagnosed CP diplegic children and 25 age matched normal subjects were selected for the study from Pune region. Age group was defined between 5 to 15 years. Children having known respiratory disease, recent chest infection and children who are hospitalized were excluded from the study.
Chest expansion at three levels was the outcome measure of the study. Measuring tape was used for chest expansion measurement [10].

Procedure

Ethical approval was taken before commencement of the study from institutional ethical committee. Subjects were informed about the study and prior informed consent was obtained. Written informed consent was obtained from the institute where CP children were enrolled from.
Procedure was explained to the subjects (i.e. for measurement of chest expansion at supramammary level the subject has to put his/her both hands above the head and for mammary and inframammary level the hands are placed over pelvic. And ask the subject first to exhale completely and then inhale) and their caretakers and parents.
Chest expansion was measured at three different levels (i.e.supramammary, mammary and inframammary level) using measuring tape for CP children and age matched healthy children.

Statistical analysis

Total 50 subjects were assessed between age 5 yrs to 15 yrs.
Mean was calculated of CP diplegic and age-matched normal children by formula,

$MEAN = \sum xi/n.$

Standard deviation was calculated.

All analyses were performed with graph pad instat statistical software.

Table 1: Type of mammary

	Supra mammary (mean)	Mammary (mean)	Infra mammary (mean)
CP diplegic	2.84±1.12	2.46±0.90	2.15±0.91
Normal	3.1±0.65	3.6±0.79	3.86±1.06
P value	0.012	0.012	0.012
t value	0.21	0.21	0.21

The unpaired T test was used and P value were calculated for three different groups ie. supra mammary, mammary and inframammary.
P value of supramammary group is-0.012
P value of mammary group is -0.012
P value of inframammary group is -0.012

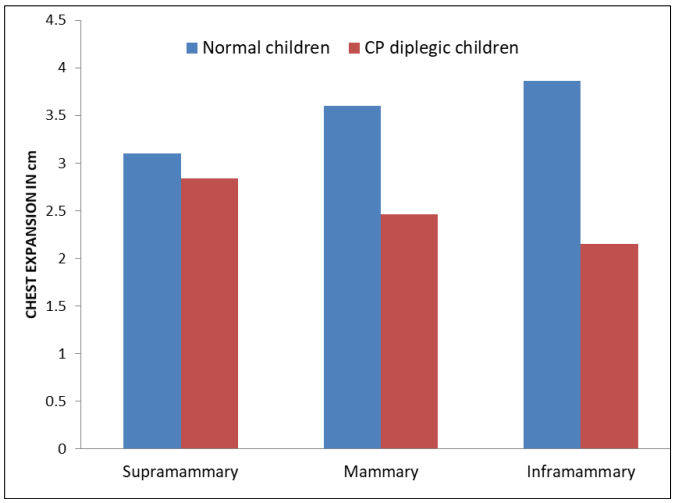

Fig 1; Levels of chest

In fig 1, there is difference of chest expansion seen in all three levels of chest and there is decreased chest expansion seen in CP diplegic children as compared to age- matched normal children though the difference is statistically not significant but clinically it is significant.

Result

In our study we found that chest expansion in CP diplegic children was lesser than that of normal counterpart, but this difference was statistically not significant, though clinically it was significant

Discussion

Chest expansion is a measurement of lungs expansion capacity and thus it reflects oxygenation status of body. In diplegic children, abdominals are weak and because of that the trunk fixation on lower body is hampered. Trunk, spine and costovertebral joints are become stiff because of that chest expansion is limited
The development in the CP child is always delayed. Child with CP has a lower activity level than normal child [4]. Normal children sit in 8 month and get standing without holding in 9 month [12]. In CP patient the process of developing milestones is delayed. These children do not attempt log rolling because of which trunk dissociation over pelvis is hampered which ultimately contributes to underdeveloped abdominals especially obliques. This activity limitation of trunk affects the bucket handle motion

of ribs. Also, effect of gravity is eliminated as these children do not achieve the milestone of sitting at a proper time.

For chest expansion, normal functions of nervous system, respiratory muscles and cost vertebral joints are needed. As CP does not have articular involvement, but there is decrease chest mobility, may be due to impaired neuromotor control, muscle spasticity and weakness, incoordination and secondary changes in the respiratory mucles [13, 14, 15].

The results of this study showed that chest expansion is decreased in CP children though it was not statistically significant when compared with age-matched normal children. Chest expansion is affected more at inframammary level as compared to supramammary and mammary level.

Normally the chest expansion occurs in three dimension i.e. In AP dimension there is forward and upward movement of sternum and upper ribs, described as a pump handle motion, this motion is a result of contraction of Scalenus muscle. In transverse dimension there is elevation and outward turning of lateral potion of the ribs, describe as bucket handle motion and increase the sub-costal angle and this motion is a result of contraction of external and internal intercostal muscles. In vertical dimension the central tendon of diaphragm descends as the muscle contracts. Elevation of the ribs increases the vertical dimension of the thorax [16].

The chest expansion at inframammary level (i.e. transverse expansion) is the result of external and internal intercostals muscle contraction, as to complete bucket handle movement [16]. As in CP diplegic children there is more affection in trunk muscle that causes the more affection of chest expansion in inframammary level as compare to supramammary and mammary level.

The results of this study is clinically significant but statistically not significant this may be because of all CP diplegic children were under physiotherapy treatment and general exercise, related to chest including trunk muscle activation, strengthening, stretching, spine mobility and bed mobility [17].

CP diplegic children have more involvement in lower limb as compared to upper limb and trunk and also have delayed milestones [2]. But delay can be minimized if treatment is given at a proper time. When child comes in sitting position the gravity acts on all respiratory and trunk muscle and on ribs, because of that there are changes in rib orientation and muscle action. All these things may help in improvement of chest expansion.

Conclusion

To conclude, chest expansion in CP diplegic children is decreased as compared to that of normal counterpart.

Limitation

In this study only CP diplegic children were taken and other types of CP were excluded.

Sample size was less.

Clinical implication

As chest expansion in CP diplegic children is less as compared to their healthy counterparts, treatment should focus on activities facilitating chest expansion.

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