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ORIGINAL RESEARCH

Differences in pulmonary function between diplegic and hemiplegic spastic cerebral palsy children

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ABSTRACT

Introduction: Cerebral palsy (CP) is considered one of the commonest causes of childhood disability. Pulmonary dysfunctions is one of the important causes of morbidity and mortality specially in moderate to severely affected children of cerebral palsy. **Aims:** This study has been designed to evaluate and compare the pulmonary function parameters ofchildren with spastic diplegia and spastic hemiplegia cerebral plays by spirometry testing.**Settings and Design:** Cross sectional comparative study was done at Physical Medicine and Rehabilitation department of tertiary care centre of North India. **Methods and Material**: Nineteen children with spastic diplegic CP and 18 children with spastic hemiplegic who satisfy the exclusion criteria were recruitedand pulmonary function parameters was evaluated with the help of computerised spirometer and compared in terms of Forced Vital Capacity (FVC), Peak Expiratory Flow (PEF), Vital Capacity (VC), Forced Expiratory Volume in 1st second, FEV1/FVC, Tidal Volume (TV), Expiratory Reserve Volume (ERV) and Inspiratory Reserve Volume (IRV). **Results:** Children with spastic diplegia have statistically significant lower FEV1, FVC, PEF and VC and no significant difference in ERV, IRV and TV. **Conclusions:** Cerebral palsy children may demonstrate compromised pulmonary function and it is more compromised in spastic diplegic group compared to hemiplegic CP children. Early clinical Assessment in these children with prompt intervention of therapy should be considered.

Keyword: pulmonary function test, pulmonary function, spasticity, cerebral palsy.

INTRODUCTION

In paediatrics population one of the most common neurological disorders encountered is cerebral palsy (CP), affecting 2-3 per 1000 live birth.[1, 2] Currently it is the commonest cause of physical disability in children. CP can lead to under development of the lung tissues and an alteration in chest wall development in children who are not fully grown.[3-5] An effective respiratory system requires a supportive structure that enables the lungs to expand adequately. This structure must be rigid enough to withstand the pressure from lung recoil, yet flexible enough to allow for proper ventilation. Any deviation from the optimal chest wall structure can lead to respiratory issues such as muscle fatigue, insufficient mechanical function, abnormal ventilation, and irregular lung volumes.[6] In view of the deficient neuro-motor control in these subjects, a possible limiting factor may be their ventilatory capacity. Children who have been diagnosed with cerebral palsy (CP) are particularly susceptible to developing significant parenchymal lung diseases and respiratory issues.[7,8] Unfortunately, these complications frequently lead to hospitalization or even death within this specific population.[9] It is worth noting that although CP itself does not directly cause respiratory problems, the reduced mobility of the chest wall and deviations from the ideal chest wall structure, resulting from inadequate respiratory

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muscle strength, are consistently associated with respiratory difficulties in children with CP.[10,11] However respiratory dysfunction is known to be a leading cause of death among individuals with CP. The pulmonary function test (PFT) is an essential tool for evaluating breathing function. It plays a crucial role in identifying the root cause of respiratory symptoms and helps in categorizing pulmonary dysfunction as either restrictive or obstructive. Not much attention is directed towards evaluation of respiratory deficiencies in children with cerebral palsy despite of presence of evidence. Paucity of data in literature, most of the literature only compare it with normal children. So this study was designed to evaluate and compare pulmonary functions between spastic diplegic and spastic hemiplegic children with cerebral palsy.

MATERIALS & METHODS

This cross-sectional comparative study was carried out at a tertiary care hospital's Department of Physical Medicine and Rehabilitation over a span of 18 months. The study included 37 children of both genders, with spastic cerebral palsy aged between 5 and 18 years. They are divided into two groups based on anatomical classification of spastic cerebral palsy diagnosis. Spastic diplegic in Group 1(n=19) and Spastic hemiplegic in Group 2 (n=18). Patients with cognitive impairment, mental retardation, visible chest abnormalities, history of cardiopulmonary disease, signs of respiratory infection and a Gross Motor Function Classification System (GMFCS) score of 4 or 5 were excluded.. Prior to initiating the study, approval was obtained from the institute's ethical committee, and written consent was obtained from the parents or guardians of all participants. The subjects underwent a clinical examination, and a detailed medical history was obtained from the participants or their parents using a study proforma. Demographic characteristics such as age, sex, residence, and socio-economic status were recorded. Pulmonary function assessment was conducted using a computerized Medisoft Spiro air spirometer, following the guidelines provided by ATS/ERS.[12] Clear instruction was given to all the participants regarding the procedure. They were first accustomed to the apparatus and the procedure, following which a minimum of 3 attempts given and best attempt was recorded. The assessment parameters recorded were Forced vital capacity (FVC), Forced expiratory volume in 1st second (FEV1), FEV1/FVC, Peak expiratory flow (PEF), Vital capacity (VC), Tidal volume (TV), Inspiratory reserve volume (IRV) and Expiratory reserve volume (ERV).

Data gathered was entered into a Microsoft Excel spreadsheet and then analysed with SPSS version 21.0 software. Categorical data was represented in number and percentage, and continuous variables were displayed as mean±SD. The normality of the data was evaluated using the Kolmogorov-Smirnov test. Unpaired t-test/Mann-Whitney test was used to compare quantitative variables, while Chi-square test and Fisher's exact test were used to compare qualitative variables. A p-value <0.05 was considered statistically significant.

RESULTS

Out of 37 CP children, 19 were spastic diplegia (Group 1) and 18 were spastic hemiplegia (Group 2). The two groups were comparable in respect of demographic characteristics [Table-1].Different flow rates and capacities of pulmonary function in terms of percentage of predictive value of both groups was listed [Table-2]. While the mean values of flow rates and capacities was compared as shown [Table-3]. A significant difference in forced vital capacity (FVC) was observed between the two groups. Difference in FEV1 between the two groups is statistically significant. Increased FEV1/ FVC was found in 13 children of group 1 and 13 children of group 2. The difference between the two groups in respect of FEV1/ FVC was non-significant. The differences between two groups in respect of PEF parameters was also significant. The mean values of different lung volumes like inspiratory reserve volume (IRV), expiratory reserve volume (ERV) and mean tidal volume of both the groups was compared [Table-4].

Table- I Demographic characteristics of both group.

Baseline characteristics	Group 1 (n=19)	Group 2 (n=18)	p value
Mean age in years	11.68±3.51	10.78±3.37	0.429
Mean height in centimetre	141.26±17.78	138.22±17.16	0.6
Mean weight in kilogram	32.9±10.67	33.00±11.55	.977
Gender distribution	Male=14 Female=5	Male=13 Female=5	0.920

Group 1: Spastic Diplegic, Group 2: Spastic Hemiplegic

Table II: Percentage of Predictive values of the flow rates and vital capacity.

Parameters	As compared to predictive value	Group 1 (n=19)	Group 2 (n=18)
FVC	Decreased	19	18
	Normal	0	0
	Increased	0	0

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FEV_1	Decreased	19	16
	Normal	0	2
	Increased	0	0
FEV_1/FVC	Normal	6	5
	Increased	13	13
PEF	Decreased	17	7
	Normal	2	10
	Increased	0	1
VC	Decreased	19	16
	Normal	0	2
	Increased	0	0

Note: Percentage of predictive value is taken Normal if in between 80-100%, Decreased if <80% and Increased if >100%

Table III: Comparison of Flow rates and capacities of both group

	Group 1			Group 2			
Parameters	**Mean ± Stdev**	**Median**	**Min-Max**	**Mean ± Stdev**	**Median**	**Min-Max**	**p value**
FEV1 (litre)	56.95 ± 9.06	56	35 - 74	67.33 ± 9.25	68	52 - 82	0.001
FEV1/FVC (%)	104.37 ± 8.7	102	88 - 119	104.56 ± 6.81	104	87 - 116	0.943
FVC (litre)	55.63 ± 8.42	58	31 - 68	64.44 ± 8	65	48 - 76	0.002
PEF (litre/Second	58.68 ± 19.59	65	23 - 90	79.06 ± 14.48	80	48 - 110	0.001
VC(litter)	61.05 ± 9.51	64	30 - 75	69.67 ± 9.53	72.5	42 - 84	0.004

Table IV: Comparison lung volumes of the children of both group

Parameters	Group 1 (n=19)	Group 2 (n=18)	p value
Mean IRV (litre)	0.65 ± 0.41	0.56 ± 0.39	0.501
Mean ERV (litre)	0.51 ± 0.23	0.55 ± 0.38	0.696
Mean TV (litre)	0.46 ± 0.15	0.47 ± 0.16	0.76

DISCUSSION

Cerebral palsy is a disorder that impacts the ability to control movement and posture, resulting from a non-progressive brain injury that occurs prenatally, during birth, or in the early years of life which results into disability in children. Respiratory infection and diminished pulmonary function rank as the chief causes of morbidity and mortality.[13] Spastic CP is the most common form of CP. Twenty percent of children with spastic CP have hemiplegia and fifty percent have diplegia.[14] So majority of the CP children are spastic diplegic and hemiplegic children.

Forced expiration relies on the assistance of various muscles, such as the abdominal and intercostal muscles. The control of respiratory muscles is an essential component of respiratory function. Evaluating the strength of these muscles is crucial for comprehending the limitations in respiratory function and their potential impact on physical performance.[15-17]

In comparison to spastic hemiplegic children with spastic diplegic showed statistically significantly lower forced expiratory function in terms of PEF, FVC, FEV1, VC might be due to less flexible respiratory muscles and decreased walking potential and physical activity. However differences in static volumes like TV, ERV, IRV and FEV1/FVC was not significant between the two groups of spastic CP. These findings corresponded with those reported in previous studies, which suggested that children with CP had significantly poor pulmonary function compared to non CP children and diplegia were more poor than hemiplegia.[9,18,19]

In a study conducted by Jan Bjure[20]the measurement of dynamic and static lung volumes was carried out in 22 subjects with cerebral palsy. The results indicated a significant reduction in total lung capacity, with an average of 85 percent of the predicted normal values. Furthermore, the functional residual capacity was found to be significantly reduced to 75 percent of the predicted value, and subjects with spasticity exhibited a 67 percent decrease in vital capacity. It was noted that the respiration patterns in these children are generally less flexible compared to those observed in normal children.

For chest expansion, normal functions of nervous system, respiratory muscles and costovertebral joints are needed.[21,22]Inadequate functioning of the respiratory muscles to effectively expand and contract the thoracic cavity can lead to the stiffening of the costovertebral joints, consequently reducing chest expansion.[22] These abnormal breathing patterns for a long period may further restrict chest mobility due to shortening of respiratory muscles and stiffening of costovertebral joints. Earlier studies have proposed that a majority of children diagnosed with spastic

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diplegic CP demonstrate a lower level of gross motor function and trunk control ability in comparison to children with spastic hemiplegic CP, as evaluated by the gross motor function classification system and trunk control measurement scale.[23-26] It is conceivable that this diminished level of physical activity and trunk control may be accompanied by a decline in respiratory function, leading to a deterioration of lung expansion due to chest mobility restrictions.Regular physical exercise is a key factor in maintaining proper airway clearance, increasing mucous removal by as much as 40% when compared to resting breathing.[27]The primary objective in managing respiratory health for those with CP should be to prevent mucous blockages that could lead to atelectasis and infections. Exercise regimens that promote deep breathing, enhance airflow, and stimulate coughing can aid in clearing secretions.[28]

The major limitation of this study is difficulty in extrapolation due to small sample size and difficulty in performing PFT in non-cooperative children. In addition, we did not consider a variety of clinical factors related to pulmonary function in terms of oxygen saturation, total lung capacity(TLC), chest wall excursion, etc. So, further study of overall pulmonary function including these factors will be needed.

CONCLUSIONS

Routine pulmonary function testing in children with cerebral palsy offers valuable insights into respiratory function abnormalities. This assessment aids in the timely implementation of rehabilitative measures, making it an indispensable tool for evaluating pulmonary function. Specially in spastic diplegic with low level of walking ability or physical performance, pulmonary function is more compromised in spastic diplegic as compared to spastic hemiplegic children. Children with spastic diplegia exhibited lower forced expiratory function compared to those with spastic hemiplegia. It is crucial to conduct early clinical assessments and provide appropriate therapeutic interventions to address respiratory function in children with cerebral palsy.

Conflicting Interest: Nil
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