



Original Article

Effects of Trunk Strengthening Exercises on Static Sitting Balance in Children with Quadriplegic Cerebral Palsy

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ABSTRACT

Background: Cerebral palsy is a neurological disorder that is caused by non-progressive damage to the brain or malformation which occurs in an underdeveloped child's brain and is considered among the most common etiology of severe disability in children. Trunk control measure was used to assess sitting balance and it was seen that universal exercise system brings a significant improvement in sitting balance of these athetoid types of children. **Objective:** To determine the effects of trunk strengthening exercises on static sitting balance in children with quadriplegic cerebral palsy. **Methods:** This quasi-experimental study was conducted at the outpatient Department of Physical Therapy, THQ Hospital Jampur. Forty patients diagnosed with quadriplegic cerebral palsy were selected using predefined inclusion and exclusion criteria. Data was collected using a trunk control measurement scale. Outcomes were recorded at the start and the end of treatment at 6 weeks in terms of gross motor function and structural deformity as recorded on the gross motor function classification scale and scoliosis status respectively. The descriptive statistics used to analyze data were presented as frequency tables. While the age and score of the trunk control measure were analyzed for its mean and standard deviation along with a graphical presentation in the form of a histogram. The tests of normality were employed for outcome variables and it was found to be non-parametric. Wilcoxon signed-rank test was used to compare the means of these non-parametric-based variables to a difference before and after treatment. **Results:** At the end of the sixth week, the mean and standard deviation for the trunk control measurement scale before and after were 12.33 ± 1.82 and 15.64 ± 2.01 , respectively while those of skewness/ kurtosis values were $-0.30/-0.23$ and $0.26/1.22$. The results of the comparison of means using the Wilcoxon signed-rank test showed that trunk control after treatment improved significantly as compared to that of before treatment (0.000), with a majority greater ranks of 16.39, while negative ranks were found to be 3.00 on average. **Conclusion:** The findings of the study concluded that trunk strengthening exercises significantly improved static sitting balance in children with quadriplegic cerebral palsy.

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INTRODUCTION

Cerebral palsy (CP) is a neurological disorder that is caused by non-progressive damage to the brain or malformation which occurs in an underdeveloped child's brain. The CP encompasses a set of neurological disorders and conditions that primarily relate to impaired movement. It is one of the leading causes of disability in children and is considered among the most common etiology of severe disability in children. It occurs in around 2 per 1000 childbirths.^{1,2} Liaqat et al. conducted a study in 2016 to investigate sitting balance improvement through the use of a universal exercise unit in addition to rocker board and gym ball training. Trunk control measure was used to assess sitting balance and it was seen that universal exercise system brings a significant improvement in sitting balance of these athetoid types of CP children.³

In another study conducted by Cho C et al., in 2016, a spherical modified balance board system was used in combination with routine physical therapy intervention to improve sitting balance in spastic paralysis children. Significant improvement was observed with this combination of treatments.³ Ross et al., in 2016 investigated the effects of strengthening exercises for trunk muscles to improve sitting postural balance and function of upper extremities because both the upper extremity and trunk were found to be interlinked in diplegic CP patients. It was concluded that strengthening exercise of trunk muscles was significantly effective in improving balance especially sitting balance in these diplegic CP children.⁴ In cerebral palsy, usually it is very challenging to engage children in exercises especially complex exercises used for stabilizing muscle tone and improving function. Therefore, before moving to phases of dynamic exercises, trunk control exercises were hypothesized to serve in multiple ways.^{5,6} There is a lot of evidence for the

impact of targeting trunk muscles on improving static sitting balance in adults, however in children and within the population of CP, the evidence is limited because of a small number of studies and also the studies being conducted are with smaller sample size and indefinite outcomes. The application of trunk muscle strengthening exercises seems to be a safe and optimal choice of intervention. This not only optimizes the sitting postural control but also targets other postural muscles leading to their powerful activation and strengthening as these muscles are poorly activated because of this centrally occurring pathology. Hence the main objective of this study was to determine the effect of the effect of trunk strengthening exercises on static sitting balance in quadriplegic cerebral palsy

METHODS

This study was a quasi-experimental conducted at the Outpatient Department of Physical Therapy Tehsil Headquarters Hospital, Jampur. The data were collected over six months using the ethical guidelines of the Helsinki Declaration and Institutional Review Board ethical approval from the University of Lahore (Ref No.: REC-UOL-44-11-2022). Patients of both genders were included if aged above six years, and pre-diagnosed with spastic and athetoid CP and gross motor functional classification system (GMFCS) level III, IV, V and quadriplegic.⁶ Patients were excluded from the study if they had any other serious illness. All participants provided written informed consent. A minimum sample of 40 CP patients was calculated based on the gross motor functional classification system based upon a previously conducted study with 0.95 as the level of confidence and power of 80% using Open EpiTool online software. The trunk control measurement scale (TCMS) is a clinical tool to measure trunk control in children with CP. It is proven clinically relevant with good validity and reliability to i.e. interrater: bias=0.57 points, 95%

confidence interval [CI] -3.71 to 4.85 ; interrater: bias= -0.31 points, 95% CI -5.77 to 5.10 . The TCMS subscores appeared to be clinically relevant because children with less than around 80% of the static balance score, less than 55% of the dynamic reaching score, or less than around 35% of the selective movement control score needed support for daily life activities. Detailed examination of gross motor functions was carried out after the initial eligibility of patients. After recording the pretreatment functional status, the standard treatment protocol including manual trunk exercises and gym ball training was applied. Each session lasted for 30 to 40 minutes and every patient received two treatment sessions per week for three weeks. TCMS scores were recorded at the start and end of treatment at three weeks. The data was analyzed using SPSS 20.0 and the descriptive statistics were used to analyze gender and gross motor function as frequency tables. During screening and treatment, scoliosis status was also analyzed and presented with frequency tables. While the age and score of the trunk control measure were analyzed for its mean and standard deviation along with a graphical presentation in the form of a histogram. The tests of normality were employed for outcome variables and it was found that trunk control measure before and after was non-parametric. Wilcoxon signed-rank test was used to compare the means of these nonparametric-based variables to a difference before and after treatment.

RESULTS

The results regarding gender showed that there were 66.7% male and 33.3% female cerebral palsy children. A systematic deviation was observed from Q-Q and detrended Q-Q plots. The detrended plot is irregularly shaped overall, with a large deviation from normality on the y-axis to be ranging in magnitude from -0.45 to 0.18 . A systematic deviation was observed from Q-Q and detrended Q-Q plots.

The detrended plot is irregularly shaped overall, with a large deviation from normality on the y-axis to be ranging in magnitude from -0.18 to 0.32 . The descriptive statistics showed that the mean and standard deviation for trunk control measurement scale before and after was 12.33 ± 1.82 and 15.64 ± 2.01 , respectively while those of skewness/ kurtosis values were $-0.30/-0.23$ and $0.26/1.22$. The histogram with a normal curve for the trunk control measurement scale before treatment was found to be 12.33 ± 1.83 , while the curve was slightly skewed positively towards higher values. The histogram with a normal curve for trunk control measurement scale after treatment was found to be 15.64 ± 2.01 while the curve was slightly skewed positively towards higher values.

The results of the comparison of means using the Wilcoxon signed-rank test showed that trunk control after treatment improved significantly as compared to that of before treatment (0.000), with a majority greater ranks of 16.39, while negative ranks were found to be 3.00 on average. The comparison of the mean score of trunk control measurement before and after treatment using paired sample t-test showed the mean trunk control score was significantly greater after treatment as compared to that of before treatment with a p-value of 0.000 and mean difference and standard deviation to be 3.30 ± 2.27 . The study also showed results regarding scoliosis that there were 27.3% without scoliosis but the rest of 72.7% were with scoliosis. The results regarding tests of normality showed that the data of the trunk control measurement scale before treatment was non-parametric as per shown by statistics of Kolmogorov-Smirnov and Shapiro-Wilk test to be 0.19 (p-value: 0.005) and 0.96 (0.266), while data of trunk control measurement scale after treatment was also non-parametric as per shown by statistics of Kolmogorov-Smirnov and Shapiro-Wilk test

to be 0.170 (p-value 0.017) and 0.903 (0.008) respectively. The results regarding gender showed that there were 66.7% male and 33.3% female cerebral palsy children, 21.2% CP children with GMFCS Level 3, 66.7% with GMFCS level 4 and 12.1% with GMFCS level 5 and 27.3% without scoliosis but rest of 72.7% were with scoliosis.

DISCUSSION

As cerebral palsy is among the top most disabling condition in children. The study was conducted to figure out whether strength training focusing on core muscles plays a role

in improving trunk function and sitting balance in patients with spastic cerebral palsy. The findings of the study showed a significant improvement in the sitting balance and trunk control and the hypothesis was accepted. The gender distribution shows a majority of male children, two times more than those of female children. This discrepancy in male and female ratio is seen less across other countries, except developing countries. Although, sociographic status in Pakistan has been much changed in the recent past and there is increasingly more awareness and less discrimination between male and female children, yet the male

Figure 1: Flow Sheet Diagram

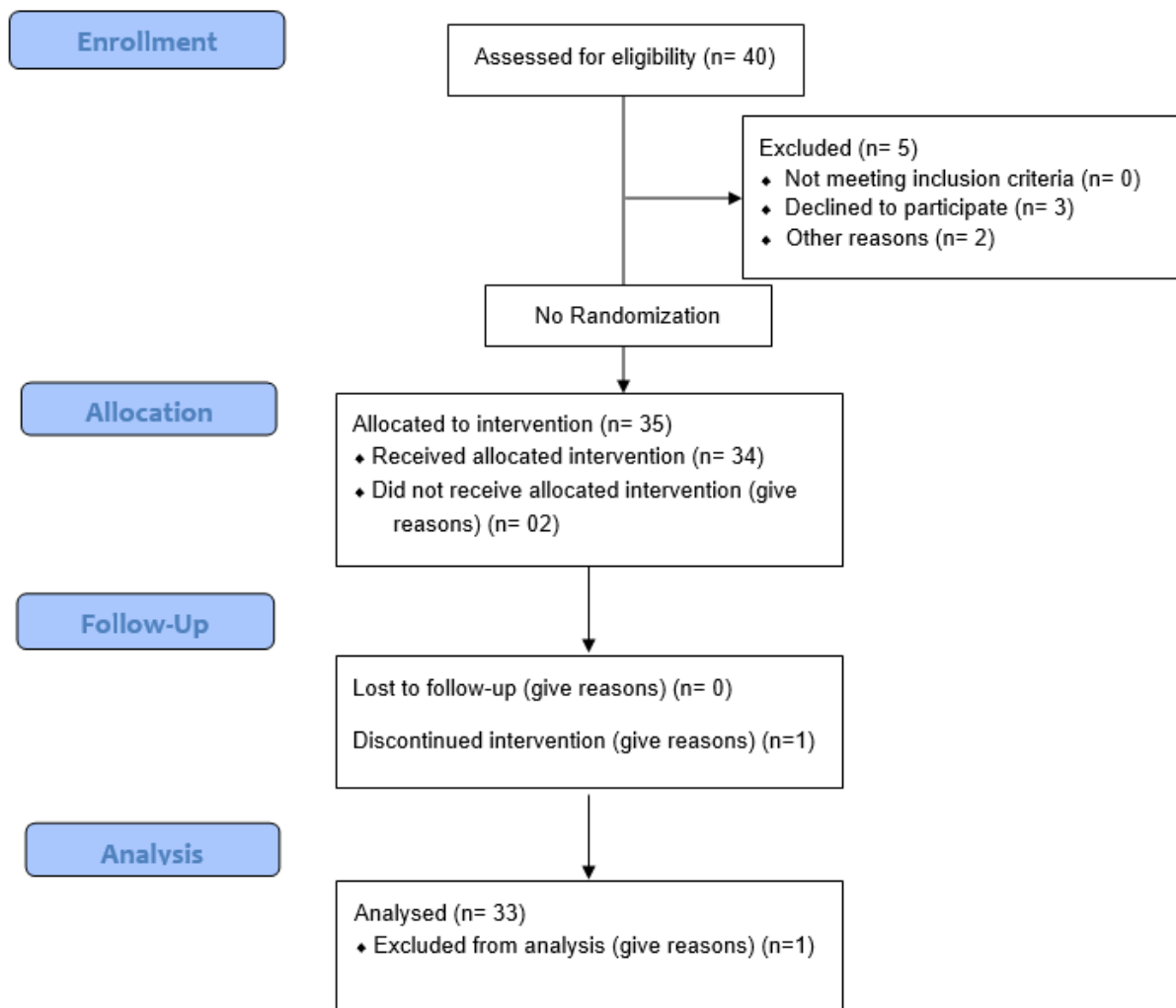


Table 1: Demographic details

Demographics		Frequency (Percentage)
Gender	Males	66.7
	Females	33.3
GFMC Level	Level 3	21.2
	Level 4	66.7
	Level 5	12.1
Scoliosis	Present	27.3
	Absent	72.7

Table 2: Within-group Comparison for TCMS

Measures	Mean±SD
Baseline TCMS	12.33 ± 1083
Post-treatment TCMS	15.63 ± 2.01
Mean Difference ^s	3.30 ± 2.27
p-value	<0.001

children with CP are greater than those of female children. There may be a naturally high prevalence of cerebral palsy in male children, however, the other factors such as male is considered earning figure and therefore, parents are inclined to invest in their treatment more than female. Furthermore, due to cultural values, parents tend to hide the illness of their female children and try to treat it at home without visiting doctors. The underlying reason should be investigated properly in further studies.^{2,7-9} In the current study there was the majority, around 70%, of children with no structural or permanent scoliosis. Literature shows that children with CP have a big chance to develop scoliosis, especially in their early life years. The level of scoliosis depends directly on the severity of

scoliosis. Although, treating conservatively may slow down the rate of developing scoliosis, surgical correction of faulty scoliosis remains the only final option. In our societal culture, scoliosis in CP children is even less than those having scoliosis due to musculoskeletal or postural issues but without cerebral palsy. This may be due to the usual routine of cerebral palsy children because they remain in bed most of the time and they are taken as lifetime bedridden individuals. They engage less in postural training or so, therefore, do not develop a permanent posture.¹⁰⁻¹² A study conducted by Ari and Gunel in 2017, conducted a study to investigate the effect of trunk control exercise on motor function because motor function is an important indicator of better functional activities. In this study trunk control exercises were based on the Bobath concept along with classical physiotherapy training was given. The study had similar findings to those of the current study that adding motor control exercises improves sitting balance.¹³

The previous literature has shown a variety of responses regarding the impact of postural control on trunk balance. Other than trunk control progressive resistance training has shown no effect on CP children. It has also been noted in an adult population where strengthening exercises have little or no impact on trunk control. The past literature suggested to improve trunk control, improving neuromuscular control is a must thing. This recommendation is also in line with findings that a blend of functional strengthening and motor control exercises are required for improving gross motor tasks. In another study, these interventions were combined with constraint-induced movement therapy and it was noted that although constraint therapy postural stability was improved the asymmetry was also increased, which on the other hand resulted in further disability.^{14,15} Although studying patients with scoliosis was

not part of the objectives during examination, screening and treatment patients eligible for inclusion were found to have scoliosis as well, so it was included for analysis and results because the intervention was equally effective in those patients as well.

CONCLUSION

The findings of the study concluded that trunk strengthening exercises significantly improved static sitting balance in children with quadriplegic cerebral palsy. Trunk control after treatment improved significantly as compared to that before treatment. The findings of the study showed a significant improvement in the sitting balance and trunk control and the hypothesis was accepted. The gender distribution shows a majority of male children, two times more than those of female children.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

Funding: No funding source is involved.

Authors' contributions: All authors read and approved the final manuscript.

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