

Effect of dual task activity programme on balance and coordination in a selected group of children aged 4-16 years with cerebral palsy (gross motor function classification system levels I and II) using telerehabilitation: A pre-post experimental study

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Background: Cerebral palsy (CP) children with gross motor function classification system (GMFCS) levels I and II experience problems in performing daily activities due to impairment in balance and coordination. Telerehabilitation refers to the use of information and communication technologies (ICT) to provide rehabilitation services to people remotely in their homes or other environments. It can prove beneficial to the family by decreasing time and costs related to travelling, family centred service and home-based delivery of care.

Objective: To determine the effect of dual task activity programme (DTAP) on balance and coordination in CP children aged 4-16 years with GMFCS levels I and II using telerehabilitation.

Method: The pre-post experimental study included 20 CP children aged 4-16 years who received DTAP using telerehabilitation with smartphone and internet for 3 days a week, for 6 weeks, each session lasting for 45 minutes. The children were assessed for balance and coordination using BOT-2 and functional mobility using the TUG test before and after intervention.

Results: CP children demonstrated significant improvement in bilateral coordination ($p < 0.0001$), balance ($p < 0.0001$) and functional mobility ($p < 0.0001$) post-intervention. There was no significant change in balance, coordination and functional mobility based on age, gender and GMFCS level.

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Conclusions: In this study of a selected group of children aged 4-16 years with cerebral palsy, GMFCS levels I and II, DTAP using telerehabilitation was found to be effective in improving balance, coordination and functional mobility.

(Key words: Telerehabilitation, Dual task training, Balance, Coordination, GMFCS levels I and II)

Introduction

Cerebral palsy (CP) is defined by the Centers for Disease Control and Prevention (CDC) as a group of disorders which affect an individual's mobility, posture, and balance¹. Gross Motor Function Classification System (GMFCS) is used commonly to categorize CP individuals into 5 levels based on functional mobility or activity limitation for the key function of ambulation². Poor balance makes it difficult to alter posture while doing functional duties such as walking and toileting. A loss of balance may result from increased postural sway³. Therefore, specific exercises for improving balance should be included in rehabilitation which could improve postural control by strengthening muscle, improving motor control and trunk range-of-motion⁴. Functional use of hands is similarly limited in CP children as hand function is crucial in daily activities, play, perception and schoolwork. For these activities, control on posture is crucial for the development of hand functions in such cases⁵. Because bimanual coordination is required for daily activities, it is critical to assess bimanual coordination using functional tasks that require asymmetrical motions⁶. According to current concepts of motor control and learning, other therapeutic activities may be more effective if they are performed in functional context which is tailored to therapeutic aim and outcomes⁷.

Dual task training may be a way to improve balance and daily activities. In a dual task intervention, one primary activity is completed while a secondary task is completed at the same time⁸. Dual task activities have been demonstrated to be useful in improving motor control in adults with neurological impairments and can take place in a variety of venues, including hospital, in-patient rehabilitation, out-patient practice, special schools, and individuals' homes⁹. The Covid-19 pandemic began in late 2019

in China and quickly spread throughout the globe, prompting the World Health Organisation to declare the outbreak a public health emergency of global concern. Many healthcare services for disabled children were cut, and paediatric therapists swiftly turned to telemedicine to help the families they had previously treated in person¹⁰. Dual task training, according to earlier studies, is useful in improving balance and coordination in neurologically challenged adults⁸. However, there is still lack of evidence on the use of dual-task training in CP children. Telerehabilitation refers to the use of information and communication technologies (ICT) to provide rehabilitation services to people remotely in their homes or other environments. It is a cost-effective method of providing healthcare at a distance and has been shown to help CP children¹⁰. It is preferred since it is critical to take required precautions during the Covid-19 pandemic and it can aid in the maintenance of function, the prevention of disability worsening, and patient follow-up. Telerehabilitation can be used to assess the efficiency of a dual task training programme for balance and coordination in CP children. Recent research has found that task-oriented workouts done

at home improve balance and coordination in CP children^{7,10}.

Objectives

To determine the effect of dual task activity programme (DTAP) on balance and coordination in CP children aged 4-18 years with GMFCS levels I and II using telerehabilitation.

Method

This was a pre-post experimental study involving 20 children with CP in the age group 4-18 years reporting at Paediatric Physiotherapy Outpatient Department (OPD) of a tertiary care hospital in Belagavi, Karnataka, India. The CP children with GMFCS level I and II, aged 4-18 years, able to follow simple commands and parents who were willing to participate in the study having smartphone with internet connection were included in the study. Children were excluded if they presented with visual/hearing impairments, cardiovascular disease, fixed musculoskeletal deformities or had undergone any orthopaedic surgeries in the past 6 months. Figure 1 gives the flow diagram.

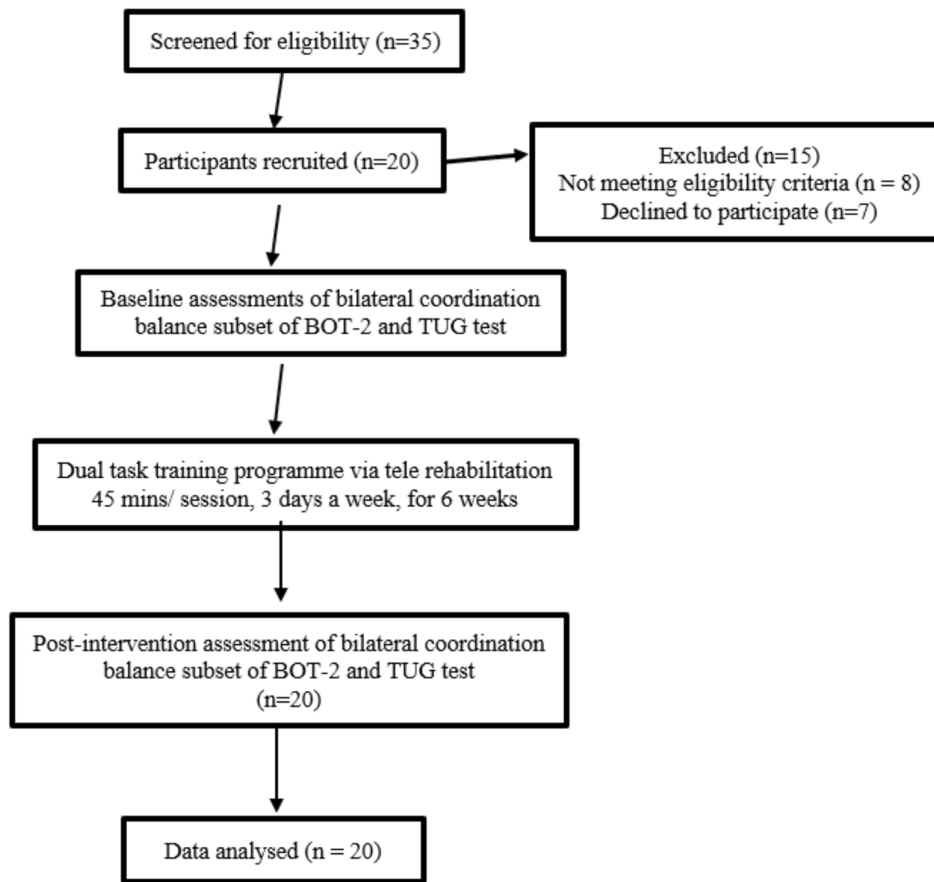


Figure 1: Flow Diagram

After screening for eligibility based on the study’s criteria, baseline assessment included demographic characteristics of participants. Balance and coordination were assessed using the balance and coordination subset of Bruininks Oseretsky Test of motor proficiency second edition (BOT-2) and functional mobility using the Timed Up and Go (TUG) test. All equipment used during assessment was sterilised before use. The pre-assessment and post-assessment were done by the primary investigator and took place in a safe and isolated setting of paediatric physiotherapy OPD of the tertiary care hospital. Precautionary measures for Covid-19 were taken according to Indian Council of Medical Research (ICMR) guidelines. DTAP was delivered by using smartphone with internet through WhatsApp. Before beginning the intervention, the participant was given a demonstration of how to perform the activity, till he/she understood the activity. Appropriate instructions and feedback, if required, were given to the participants during the training sessions. The participants were instructed to perform two activities simultaneously. The parents were requested to stand close to the patient in order to ensure the participant’s safety and avoid falls during therapy.

All sessions were supervised by the researcher through smartphone. Before beginning each session, warm up exercises, upper and lower extremity range of motion (ROM) exercise and stretching were given for 10 minutes. The exercises were single leg standing, sit to stand, step up and sideward, walking on fixed base of support and unstable surface with eyes open and closed for 1 minute performed for 3 sessions. While performing exercises walking and

carrying a glass of water, walking and carrying a tray with glasses, coin transfer, buttoning, walking and bouncing a ball, catching or throwing a ball were performed. One to two minutes’ pause was given after each activity by primary investigator to avoid fatigue in the children. At the end of each session cool down exercises stretching and deep breathing were given for 10 minutes Each session lasted 45 minutes and was performed by the child 3 days per week for 6 weeks.

Ethical issues: KLE Institute of Physiotherapy Research and Ethics Committee (KIPT/SI No.582/16-07-2021) approved the study protocol. Written informed consent was obtained for the study after explaining the purpose and intervention to the parents or guardians in their vernacular languages. The trial was registered under Clinical Trial Registry of India under the registration number CTRI/2021/11/037711.

Statistical analysis: Data were analysed using statistical software SPSS version 22. Continuous variables were represented by mean and standard deviation. Categorical variables were represented by frequency tables. The normality of the data was checked using Kolmogorov Smirnov test. The dependent t-test was used for non-significant variables. The Wilcoxon signed rank test was used for significant variable. p-value <0.05 was considered significant.

Results

Table 1 gives the demographic characteristics of the children with CP.

Table 1: Demographic characteristics of the children with cerebral palsy (n=20)

Characteristic		Number (%)
Age groups	4 – 9 years	13 (65)
	10 - 16 years	7 (35)
Gender	Male	16 (80)
	Female	4 (20)
GMFCS level	Level I	10 (50)
	Level II	10 (50)

GMFCS: Gross Motor Function Classification System

Table 2 shows the comparison of pre-intervention and post-intervention scores of bilateral coordination of BOT-2 with z value of 3.8230 and p

value <0.0001. Hence, bilateral coordination component of BOT-2 shows a significant improvement post-intervention.

Table 2: Comparison of pre and post intervention scores of bilateral Coordination of BOT-2

Time point of assessment	Mean ± SD	Mean Diff. ± SD Diff.	% of change	Z-value	p-value
Pre intervention	7.20 ± 4.44	-1.85±0.75	-25.69	3.8230	0.0001*
Post intervention	9.05 ± 4.75				

*Level of significance (p<0.05), SD- Standard deviation

Table 3 shows the comparison of mean values of pre-intervention and post-intervention of balance scores of BOT-2 with t value was -5.8709 and p

value was <0.0001. Hence, balance component of BOT-2 shows significant improvement post-intervention.

Table 3**Comparison of mean values of pre and post intervention of balance scores of BOT-2 by dependent t test**

Time point of assessment	Mean ± SD	Mean Diff. ± SD Diff.	% of change	Z-value	p-value
Pre intervention	4.55±3.61	-1.90±1.45	-41.76	-5.8709	0.0001*
Post intervention	6.45±4.24				

*Level of significance ($p < 0.05$), SD- Standard deviation

Table 4 shows the comparison of mean values of pre-intervention and post-intervention of body coordination standard scores of BOT-2 with t value

-7.2918 and p value < 0.0001 . Hence it shows significant improvement in body coordination post-intervention.

Table 4: Comparison of mean values of pre and post intervention of body coordination standard scores of BOT-2 by dependent t test

Time point of assessment	Mean ± SD	Mean Diff. ± SD Diff.	% of change	Z-value	p-value
Pre intervention	30.25±7.43	-3.80±2.33	-12.56	-7.2918	0.0001*
Post intervention	34.05±8.31				

*Level of significance ($p < 0.05$), SD- Standard deviation

Table 5 shows that comparison of mean values of pre-intervention and post-intervention of TUG scores with t value was 9.1303 and p value was

< 0.0001 showing significant improvement in functional mobility post-intervention.

Table 5: Comparison of mean values of pre and post intervention of TUG scores by dependent t test

Time point of assessment	Mean ± SD	Mean Diff. ± SD Diff.	% of change	Z-value	p-value
Pre intervention	8.97 ±1.10	0.73 ±0.36	8.18	9.1303	0.0001*
Post intervention	8.24 ±1.03				

*Level of significance ($p < 0.05$), SD- Standard deviation, TUG- Timed up and go

Discussion

The current study used telerehabilitation to evaluate the effect of a dual task training programme on balance and coordination in CP children. The findings reveal that 6 weeks of dual task training using telerehabilitation improved balance, coordination, and functional mobility of CP children aged 4 to 18 years. To the best of our knowledge, this is the first study to look into the impact of dual task activity using telerehabilitation on static and dynamic balance and upper and lower extremity coordination with functional mobility in CP children. The findings support prior research which found significant impact of a dual task activity programme on balance for developmental coordination disorder children in age group of 7 to 9 years¹¹. A study conducted to improve motor skills in Intelligence Quotient (IQ) discrepancy children aged 6 to 13 years reported that dual task activity had more effect than standard balance training¹². A case study on task-oriented approach for balance, mobility, coordination and speed for upper-lower extremity and strengthening was conducted and showed significant improvement⁷. A study showed significant impact of dual task programme on gait and posture in healthy and CP children in age group of 7 to 12 years¹³. A systematic review reported that the most common dual task activity programme was 45-60 minutes, twice a week for an average of 6 to 12 weeks¹⁴.

Telerehabilitation has long been regarded as a viable option to provide paediatric therapies; nevertheless, constraints such as cost, payee reimbursement, and access have kept it from being widely used. With the onset of the Covid-19 pandemic, telerehabilitation was quickly adopted in clinical practice to maintain social isolation while allowing access to care¹⁵. A prior study reported that telerehabilitation was beneficial to improve upper and lower extremity functions in daily activities for CP children aged 2 to 18 years, divided under GMFCS levels I and II and MACS levels I to III¹⁶. So, the current study used telerehabilitation as a mode of delivery.

The study's impact can be attributed to the home-based setting, and family-centred approach of intervention delivery. The child was treated in an environment where he was expected to engage in regular activities, which may have contributed to the effectiveness of the intervention. It could have been effective due to reduced fear of hospital environment and improving parent-child interaction as the programme was delivered by the parent. For parents, telerehabilitation was found to be convenient as it reduced financial expenses due to travelling, personal preference for isolation due to the pandemic, reducing cost of healthcare and challenges while travelling and importantly monitoring and receiving-giving feedback. It can be considered as complementary treatment to standard physiotherapy programme so telerehabilitation was

preferred to deliver the dual task training programme.

The dual task activities are dynamic exercises which require coordination between the upper and lower limbs, resulting in weight transfers. The children in our study had practised not just the motor with balance requirements activities, but also the secondary task of a DTAP. It was beneficial for the participant to perform motor or balancing activity and secondary task at the same time while giving constant attention to both tasks. It is suggested that activity to maintain balance and perfect alignment of posture initiates as means of adapting to the activity so that individuals may enhance their balance, coordination, and functional mobility through autonomic responses⁷.

During activities, DTAP activates conscious control mechanisms and attention strategies while decreasing automatic control. The effect of attention in increasing cortical plasticity in somatosensory, motor cortex and enhancement in functional activity may be connected to dual-task programme potent influence. Plastic changes in the brain are elicited by the DTAP⁷. While performing the activity the affected hand tries to mimic the unaffected hand in order to complete the activity. These modifications result in an increase in neural processing efficiency as well as the enforcement of the cerebellar-cortical circuit^{13,17}. Review of the effect of dual-task training concluded that combination of other active therapies and balance training helped in improving static and dynamic balance via task performance¹⁸.

All children in the study performed the components of BOT-2's bilateral coordination and balance subgroup as well as the TUG test. However, compared to performance of normal children of similar age, most CP children had below-average performance on balance and coordination component of BOT-2 before intervention. In addition, the children took longer to complete the TUG test than the norms for their age. A study conducted to investigate and compare their findings in CP children found similar results^{3,19}. The motor cortex and cortico-spinal circuits may be disrupted, resulting in reduced levels of balance, coordination, and functional mobility. Neurological injuries lead muscles to be asymmetrically shortened, the shorter muscles are more easily mobilized than the stretched antagonistic muscle on the unaffected side, causing the shortened muscle's degree of tension to rise which leads to difficulty in maintaining control of the body and fine control of hand while performing any activity which is connected with functional mobility⁹.

Several limitations should be highlighted. There was an absence of a control group in this study and also

the sample size was small. While conducting the programme using telerehabilitation, disruption in internet connection, lack of electricity and time management are factors which could cause an incomplete therapy session. Families from rural populations, due to lack of smartphone and internet, were not able to participate in the study. Therapist had difficulty to correct the parent or child whenever they use to perform activities incorrectly. There was lack of therapist-patient interaction.

After the sessions, the study found a considerable enhancement in the static and the dynamic balance, upper and lower extremity coordination and functional mobility. This is reinforced by research that suggests dual task training programme using telerehabilitation requires individuals to repeat distinct movements sequences, performing dual task with challenges, attention and motivation to complete activity. As a result, the use of a dual-task training programme in functional component of children diagnosed with CP can be considered as effective clinical intervention strategy.

Due to the lack of a control group and the low sample size, conclusions should be treated with caution. Whilst the results are encouraging, further evidence using a randomised controlled study design and with an increased sample size is recommended.

Conclusions

In this study of a selected group of children aged 4-16 years with cerebral palsy, GMFCS levels I and II, DTAP using tele-rehabilitation was found to be effective in improving balance, coordination and functional mobility.

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