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Test Retest Reliability of 6 Minute Walk Test and 1 Minute Walk Test in Spastic Cerebral Palsy

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Abstract

Background and objectives: Timed walk tests over 1 and 6 minute intervals have been developed for use in evaluating patients with cerebral palsy but on a smaller sample size. Moreover it is important to establish its reliability according to their gross motor function classification system levels and in an age stratum for conclusive results.

Methods and materials: A total of 70 spastic cerebral palsy participants of age group 7 to 18 years took part in the study , who were classified according to GMFCS level .The walk tests were performed on the same day and retest was done after 7 days.

Results: The test retest reliability of 6 min walk test and 1 min walk test was obtained by cronbach alpha and the value was 0.99 and 0.97 respectively.

Conclusions & interpretations: The 6 min walk test and 1 min walk test has shown high test retest reliability across all gross motor function classification system levels.

Keywords: Cerebral Palsy; 6 minute walk test; 1 minute walk test.

Introduction

Cerebral palsy is defined as a persisting but not unchanging disorder of movement and posture, appearing in the early years of life and due to a non-progressive disorder of the brain, the result of interference during its development.[1] The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, behavior and by secondary musculoskeletal problems.[2] The prevalence of cerebral palsy is approximately 2.12-2.45 cases per 1000 live births, indicating a slight rise in recent years.[3] Improvements in neonatal nursing have helped reduce the number of babies, who develop cerebral palsy, but the survival of babies with very low birth weights has increased, and these babies are less likely to have cerebral palsy.[4] ,[5] [6] Walking is a complex functional activity; thus, many variables contribute to walking speed. [7,8,9] The ability of children with cerebral palsy to walk has been quantified in various ways, from the relatively simple measures of velocity, step length, and cadence to the more sophisticated measures of kinematics and kinetics, as provided by instrumented three-dimensional analysis but many children have difficulty in tolerating the equipment, particularly the face mask, for the sustained period required for testing indicating the need of some simple tests which are easily clinically applicable.[10] ,[11] The walking time required to achieve steady state varies in the literature from 3 to 10 minutes consequently many children with more disabling forms of the condition are unable to complete this type of test.[12] Butland et al. investigated the possibility of using shorter walking times in patients with respiratory

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disease and found that 2 and 6 minute walks were as reproducible as a 12 minute walk.[13] . Timed walk tests are also now being used as measures of functional ability in clinical intervention trials that involve children with cerebral palsy.[14,15] The 6-minute walk test is a self-paced, sub maximal test that assesses functional capacity for walking a prolonged distance.[16,17] It may reflect exercise tolerance required for the performance of ADL,[16] and predict ability to walk in the community.[17,18] The 6MWT is increasingly used in the young children in whom performing cardiopulmonary exercise tests is especially problematic, requiring a high degree of cooperation, good coordination and motivation[19,20]. A new test i.e. 1 min walk test has been frequently used recently in children with cerebral palsy to measure functional abilities. 1 minute walk is considered as a potential measure of functional ability and walking endurance[21]. Testing a child at their maximum walking speed would be a greater discriminator of their functional ability for dynamic balance, muscle performance, and endurance than that recorded at a self-selected speed. The duration of 1 minute allow the testing of most children with ambulatory cerebral palsy. The distance covered on the fast 1MWT has a significant relationship with net oxygen cost,[22] a traditional measure of exercise capacity, and also correlates with the Gross Motor Function Measure-66, a global measure of functional ability score.[23] The gross motor function classification system (GMFCS) was developed to describe gross motor function in children with cerebral palsy and has its focus on self-initiated movements, in particular sitting and walking.[24] It is an age-related five-level system in which level I represents the least limitation and level V the most. The GMFCS has been internationally accepted and is widely used. [25],[26,27] Although the reliability of 6 min walk test and 1 min walk test has been studied in the cerebral palsy population but it was done on a smaller

Figure 1: Sphygmmomanometer, Measuring Tape, Pulse Oximeter And Stop Watch

sample size. So there is a need to study it on a larger sample size as devised by Donner and Elaisziw for reliability study sample size calculation, there should be atleast 40 participants within a single GMFCS level or age stratum to be confident of reliability of 0.90. Also, the 1 min walk test being relatively new, its efficacy needs to be studied further in the above population.

Methodology

The data was collected from special schools in Delhi and NCR. A total of 70 children diagnosed with spastic cerebral palsy were included in the study within the age range of 7-18 years and were classified as per GMFCS Levels I, II and III as determined by their developmental pediatrician . The children included were able to walk independently without stopping for 6 minutes, with or without a walking aid and were also able to follow verbal instructions. Those who underwent Orthopaedic surgery within past 6 months, who took Botulinum toxin type A injection in the lower limb within past 6 months., who were Currently ill, or those who have any documented cardio respiratory comorbidity or any documented mental retardation or intellectual disability were excluded .Children who had scores less than 24 on mini mental state examination were also excluded. The materials included weighing machine, stadiometer, stop watch, measuring tape, pulse oximeter, syphygmomanometer, two small cones, telephone and a chair. (Fig 1)

Procedure

A written informed consent to participate in the study was obtained from a legal guardian of each participant. The height and weight were taken on the first day of visit. The walking course was set in the corridor. Children wore their own clothing and shoes, allowed to wore their splints and use their walking aids as appropriate. Instructions were given clearly to the participants before the procedure. The 6 minute walk test and 1 min walk test were performed on the same day. The 6 min walk test and 1 min walk test were randomly done with half an hour of seated rest. The retest was done after one week respectively for both tests.

6 minute walk test

The walking course was set in a quiet, rectangular corridor and marks were taped on the floor at 20-meter intervals. The turnaround points were marked with a cone. Children were instructed to walk as many laps as possible in 6 minutes without running. A demonstration was given to the children for one lap. The procedure was, the child was made to sit at rest in a chair, located near the starting position, for at least 10 minutes before the test started. During this time, the heart rate, blood pressure and oxygen saturation were recorded. The child was made to stand and their baseline dyspnea and overall fatigue using the Borg scale were recorded. The object of this test is to walk as far as possible for 6 minutes. The children walked back and forth in the ground. They were permitted to slow down, to stop and to rest as necessary if they get exhausted or breathe out. They may lean against the wall while resting, but resume walking as soon as they were able to. They were instructed to walk back and forth around the cones and pivot briskly around the cones and continue back the other way without hesitation. The child was positioned at the starting line. The therapist also stood near the starting line during the test. As soon as the child started to walk, the timer was started. They were not allowed to talk to anyone during the walk. An even tone of voice was kept when using the standard phrases of encouragement and the child was watched. After the first minute, the command given was: "You are doing well. You have 5 minutes to go." When the timer shows 4 minutes remaining, the child was instructed as the following: "Keep up the good work. You have 4 minutes to go." When the timer shows 3 minutes remaining, the child was told the following: "You are doing well.

Figure 2: The subject walking during the test

You are halfway done." When the timer shows 2 minutes remaining, the child was told the following: "Keep up the good work. You have only 2 minutes left." When the timer shows only 1 minute remaining, the child was told the following: "You are doing well. You have only 1 minute to go". When the timer ranged, the command was: "Stop!" The therapist then walked to the child and took the chair if they looked exhausted. The spot where they stopped was marked by placing a piece of tape on the floor. The post walk Borg dysponea and fatigue levels were recorded by asking the child. By using pulse oximetry, SpO2 and pulse rate were measured from the oximetry. The number of laps taken by the child and additional distance covered were recorded.

1 min walk test

It was done on the same track. They were instructed that whenever the instruction given to them to start they were to keep walking around the track as fast as possible for 1 minute. They were not allowed to run. Distance was calculated by the meter markings on the floor. The assessor explained the protocol to each subject before the test, demonstrated one lap of the track and gave the order to start and stop. The distance was calculated during the 1 minute. The heart rate, oxygen saturation, blood pressure and fatigue levels were taken before and after the test. (FIGURE 2)

Results

The data was collected from 70 subjects and it was statistically analyzed.

(Table 1),(table 2) , (table 3) , (table 4) , (table 5)

The result depicts the mean distance walked by these children. d1 represents the first day the walk tests were conducted and d7 represents the 7th day when the tests were reconducted.

The significant differences was present between males and females for 6 min walk test at level p<0.05. There was no significant difference present between males and females for 1 min walk test.

Table 1: Mean and standard deviation of 6MWD & 1 MWD

Walk Tests	N	MEAN(m)
6 min walk distance(d1)	70	426.19±74.9
6 min walk distance(d7)	70	434.20±76.71
1 min walk distance(d1)	70	71.79±13.38
1 min walk distance(d7)	70	73.97±14.82

Table 2: Test retest reliability values of 6 MWT AND 1 MWT

GMFCS LEVELS	N	Cronbach's alpha 6 min walk test	Cronbach's alpha 1 min walk test
All subjects	70	.99	.97
GMFCS-I	34	.84	.92
GMFCS-II	25	.96	.90
GMFCS-III	11	.98	.93

Table 3: Effect of gender upon distance walked

	GROUP	N	Mean	Std. Deviation	SIG (2-tailed)
6 min walk test	Males	33	443.64	61.87	0.043
	Females	37	410.62	82.58	
1 min walk test	Males	33	73.85	12.92	0.158
	Females	37	69.95	13.69	

The positive correlation was found significant between the height and walk distances at p< 0.05 level.

The positive correlation was found significant of age with both walk distances at p< 0.05.

Table 4: Correlation between height and walk distance

		6 min walk distance	1 min walk distance
Height	Pearson Correlation	.432	.364
	Sig. (2-tailed)	.000	.002
	N	70	70

Discussion

70 subjects met the inclusion criteria of being in the age group of 7 years to 18 years and constituted the study sample in which 34 subjects were in GMFCS I, 25 in GMFCS II and 11 IN GMFCS III. The mean distances walked by all the subjects in 6 min walk test was 426.19m & 434.2 m at baseline and retest respectively. The results of this study are consistent with the results of Maher[28] who found out 448.7m and 449.5m respectively for test and retest at half an hour interval in the age group 11-17 years where as C Andersson[29] has reported that the mean distances walked by the subjects at the four tests were 316, 336, 341 and 345m within two week interval. This difference in results could be due to elderly age range *i.e.* 26-58 years, more number of subjects in GMFCS III and less sample size. There was no significant difference in the 6 min walk distance reached at two time points separated by a mean of 7 days. The test retest reliability of 6 min walk test was found to be high. This was consistent with the results of Maher[28] and Patricia Thompson[30] who found out ICC 0.98 in children with cerebral palsy whereas C Andersson[29] has stated ICC 0.99 in adults with cerebral palsy but all these studies have given their reliability values on a comparatively small sample size. The data regarding the mean distances walked across all gross motor function classification system levels has been collected to find out the affect of GMFCS levels on the distances walked. The results were consistent with the results of Maher et al[28] and Patricia Thompson et al[30] except for GMFCS III. These studies have stated the mean distance walked by these children in GMFCS III were 234.7m and 254.7m respectively. The reason behind this variability could be the severity of spasticity

Table 5: Correlation between age and walk distance

		6 min walk distance	1 min walk distance
Age	Pearson Correlation	.447	.411
	Sig. (2-tailed)	.000	.000
	N	70	70

and the duration of intervention taken by these children. The distance walked has decreased with the increased GMFCS levels. There was no significant difference found between test and retest within all GMFCS levels. The 6 min walk test across all GMFCS has showed good to high reliability values. In the present study the reliability value for GMFCS I differs from the study of Maher [29] and C Andersson[29] who found out ICC 0.93. This could be due to faster children in this group which had increased the retest distances. These children had perhaps more physical capability to speed up on the retest after perhaps realizing from their first attempt that they could have gone faster. Conversely, children in Level III with their greater physical restriction and associated limits to performance were most consistent in their distance covered as demonstrated within each of the 6MWT analyses.[30] The distance walked by children of age stratum 7-12 years was 245m-502m and the mean distance was 403.2m. It shows the average distance walked by the children of this age group. The major problem observed with cerebral palsy children in this study was 'spasticity' in their legs rather than cardiorespiratory problems and this was the main reason for their reduced walking distance. These findings were confirmed by the study of Andersson[29] who showed that there was no correlation between heart rate and perceived exertion/ heart rate and walking distance. These results are also confirmed to a certain extent by Bean et al. who found that the six-minute walk test was a useful measure of functional limitation among mobility-limited elders without cardiorespiratory or peripheral vascular distance. There was a strong correlation found between the height and 6 min walk distance. This can be attributed to the longer length of steps in taller individuals. The length of the step is one of the main determinants in gait velocity. Some studies like Troosters T et al[31] and Lammers AE[32] have shown a strong correlation of height with 6 min walk distance whereas only the study of Enright and Sherill[33] did not show a significant correlation. Age too had a significant influence on the 6MWD in several studies and in the present study also there was a strong correlation found between age and 6 min walk distance. In the studies involving children and adolescents[32] a positive correlation was seen whereas in the studies involving healthy adults and elderly individuals [33, 31] a negative correlation was observed. The correlation between age and 6MWD was not significant only in the study by Camarri et al[34] due to narrow age range assessed by the study. The shorter distance walked as age increases can be explained by the decrease in muscle mass and strength and the maximum oxygen consumption, inherent to the aging process. On the other hand, the positive correlation between the 6MWD and age < 20 years is the result of the higher degree of maturation among adolescents, as compared to children. In the present study there was a significant difference noticed in 6 min walk distance based on gender. Males were found to have greater 6 min walk distance than females possibly as a result of their greater muscle mass and the ability to achieve higher levels of physical activity. This was consistent with the results of Albert M. Li[35] in which the 6 min walk distance was higher in males than females. The same result is stated by A.M. Iwama[36] ,the difference being attributable to the greater absolute muscle strength, muscle mass and height of men compared to women. There was a weak correlation found between BMI and distances walked. This is supported by the study of Iwama[36] who said that 6MWD being shorter in subjects with greater body weight or higher BMI. Unlike the protocol for the original 6 min walk test as given by the American Thoracic Society, the practice trial was not included in this study. This decision was made on work by Van Loo[17] which demonstrated no significant learning effect

when adults with spasticity did the 6 min walk test trials. This same result has been supported by Maher[28] that the distance walked during the 6 min walk test varied by less than 1% between the two trials suggesting that a practice walk is not necessary. These findings are in contrast to those of Andersson and colleagues[29] whose study on adults with cerebral palsy reported an improvement of 7% between trials 1 and 2. It is difficult to tell whether the different findings in this study were due to inherent differences between the pediatric and adult cerebral palsy populations or methodological differences in the way the 6 min walk tests were conducted between studies. According to Fry DK[20] et al a practice trial was not given for this lengthy test because of concerns about the impact of associated fatigue. Sciurba[37] hypothesized that long corridors are more effective when compared to short corridors for the walk test because, in the long corridors, the number of turns is reduced and, therefore, the effort is smaller. Nevertheless, in this study, the walked distances in the long corridor were not statistically greater when compared to the shorter corridor. Therefore, the authors concluded that the length of the corridor during the test would not be relevant to its standardization. However, the corridor should not be shorter than 15.23 meters as stated by Scuirba[37], unlike the American Thoracic Society minimum standard of corridor length which is 30 meter. The study by Troosters T[31] had compared the 20 and 50-meter corridors for the test in adults and found no significant differences in the walked distance. Maher[28] has used a 10 m straight course which is considerably shorter than the 30m course recommended by the American Thoracic Society[16]. Although a 30m indoor course can often be found in hospital settings, in many cases young people with cerebral palsy are seen by health professionals in community settings where a 30m course may not feasible. The results indicated that 6 min walk distance can be achieved using a 10 m course for cerebral palsy population.[28] The results for 1 min walk test differed with the study B.C. McDowell[21] whose observations were 81.4m and 81.4m at baseline and retest respectively. The reason behind this could be due to a smaller sample size (17 subjects) in the above quoted study. The test retest reliability value of 1 min walk test was consistent with the study of B.C.McDowell[21] who found ICC 0.94 and the repeatibilty coefficient was 13.1. This coefficient suggests that for individual patient data, walking distance may vary by up to 13 m between test occasions. In practical terms, this means that a child with bilateral spastic cerebral palsy (GMFCS levels I–III) would need to demonstrate an improved walking distance of at least 13 m following an intervention before one could attribute the change as 'real'. The significant differences in 1 min walking distances were noticed between GMFCS levels. The mean distance walked by the cerebral palsy children may provide a quick guide to expected walking distances for GMFCS I to III. There seems to be significant difference in the distance walked between GMFCS I and II but not much difference between levels II and III. This result concurs with previous findings in studies done by Baker R.[10] which demonstrated a significant relationship between the 1 min walk test and functional ability(r=0.92). The distance walked by these children of age stratum 7-12 years was 39-93m and the mean distance was 67.54m±13.52m. Age and height was found to be significantly correlated with the 1 min walk distance.. There was not significant gender difference found in 1 min walk distance. A negative correlation was found between BMI and 1 min walk distance. The anthropometric values were correlated in the study for the first time. The test is shorter in duration to other well reported walk tests of 2, 6 and 12 min , and therefore likely to be a poorer discriminator of exercise tolerance which is a limitation. Alternatively, the 1-min protocol is likely to be more acceptable for the majority of ambulant children with CP, particularly those children in GMFCS level III that use walking aids and/or a wheelchair for mobility within the community. Furthermore, due to the short duration of the test, it is more feasible to be included within a battery of tests assessing gait in CP[21]. This study found that

the distances walked either in a fast-paced 1min walk test or a self-selected 6 min walk test were highly correlated both with each other and with the GMFCS, suggesting that in practical terms, both of these timed walk tests are measuring the same construct. Still a large number of data is required across each gross motor classification system level for more conclusive results. The effect of puberty on 6 min and 1 min walk distance can be seen in further studies. A study by Spadano[38] stated that absolute total energy expenditure and physical activity level increased after puberty. Hence further study can compare the children and adolescents. Similar assessment of the 6 min walk test and 1 min walk test would need to be repeated in other age groups of cerebral palsy to ascertain its reliability and validity as age, sex and height have all been shown to affect the distance walked.

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