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A Novel Approach to Upper Limb Task Specific Training in Children with Hemiparesis

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Abstract

Introduction: Studies of task specific training in children traditionally make children to perform tasks for some periods of time. However, this method may not show clearly how much task was practiced. Recently, alternative way of measuring amount of task practice has been proposed. This method uses the number of task repetition. Task repetition up to 300 times per day was possible in adults. Feasibility of this amount of task practice is however not clear in children. Aim: The aim of this study was to find out the feasibility of 300 task repetitions spread over 3 sessions per day, and that whether the intervention can cause upper limb pain.

Method: Seventeen children with hemiparesis were included in the study. They were made to practice 5 tasks, each 20 times per session, 3 times a day for 4 weeks. PMAL and TAUT were used to measure motor function at baseline and 2 and 4 weeks post-intervention. The data was analyzed using repeated measures ANOVA.

Result: The result of the study showed a significant effect of task specific training from baseline to 2 and 4 weeks post-intervention on TAUT (AOP, QOU & AOU) and PMAL (AOU & QOU), and no evidence on increased upper limb pain on VAS from baseline.

Interpretation: The result indicates the feasibility and effectiveness of 300 repetitions of task practice spread over 3 sessions per day in children with hemiparesis.

Keywords: Hemiparesis; Task specific training; Children; Motor function; Motor recovery

Introduction

Following injury, the brain relies heavily on learning to recover motor function. One of the ways to induce this recovery of motor function is through task specific training. Task specific training is a form of rehabilitation technique designed based on the same tasks we carried out in everyday life such as brushing our teeth and taking spoon and/or hand from the plate and then to the mouth. In studies on children, task specific training is usually performed for specific periods of time such as 3 hours and 6 hours per session per day for 15 and 21 days respectively [1-3]. In practice, it may however be difficult to determine the intensity or dose of task that was practiced by considering only the time spent practicing the task. In response to the above mentioned difficulty, studies have recently emphasized the usefulness, ease and feasibility of using number of task repetitions to appropriately determine the amount of task needed to be practiced per session and/or day that would result in recovery of motor function [4-6]. In these studies, when functional tasks were performed as high as 320 and 322 times per session(s) per day respectively, recovery of motor function was recorded which was up to the level of minimal clinically important difference (MCID) in the former study.

Furthermore, compliance with practicing tasks and constraint for long hours in children as in the traditional protocols could also be a point of great concern. For instance, in the study by Gordon and colleagues, the treatment had to be scheduled during holidays to avoid interfering with schooling [2]. Similarly, children between the ages of 3-14 years are in their physically active phase of life [7]. Thus, constraint for long hours could interfere with play activities especially, and impact negatively on the children compliance. Therefore, since the number of repetitions required for functional reorganization of the brain and subsequent improvement in motor function is known, and that the amount can be performed within either short or long duration [6,8]; we intend to find out the feasibility of 300 repetitions of task practice spread over 3 sessions per day in children to accommodate patients' and therapists' other needs such as schooling and attending to other patients respectively.

Methods

The study was a quasi- experimental study with time series design of pediatric task specific training without constraint. The study was approved by the Research Ethics Committee at Aminu Kano Teaching Hospital, Nigeria where the study was carried out. The population of this study was children between 3 to 13 years of age diagnosed of hemiparesis who were receiving Physiotherapy at Aminu Kano Teaching Hospital. The inclusion criteria were children diagnosed of hemiparesis secondary to any aetiology such as sickle cell disease and cerebral palsy, children between 3 to 13 years of age, children with ≥ 20° of wrist extension and ≥10° of extension at metacarpophalangeal joints and the interphalangeal joints, patients who gave their consents, children who have the ability to understand instructions, obey command, and recognize family members and the surrounding environment such as the study hospital.

The patients were recruited consecutively and given intervention (task specific training) for 4 weeks between 28th November, 2013 and 13th January, 2014. The participants were assessed for upper limb motor function, upper limb pain, and wrist and finger extension using Paediatric Motor Activity Log (PMAL) and Toddler Arm Use Test (TAUT), 10cm Visual Analogue Scale (VAS) and a full circle goniometer respectively. The intervention involved teaching the children and their relatives how to perform the following tasks: eating from the plate with a spoon, brushing the teeth, combing, moving a toy from one point to another and picking something from a container and putting it into another container. They were then asked to perform each task 20 times per session, 3 times a day, 5 times a week for 4 weeks at home under the supervision of the relatives. All children were asked to perform same tasks as described above to prevent difference in baseline motor ability and the propensity of one task to produce a better effect than another from impacting on the outcomes.

To ensure compliance with the task practice protocol, a logbook was designed by the authors that the relatives filled in compliance with the protocol. Secondly, patients and their relatives were interviewed and the patients were observed on weekly hospital visits. Thirdly, the relatives were contacted on telephone from time to time. However, we did not use constraint so that we could avert poor compliance as children may not love to see their arms constrained in mitts. Additionally, studies in children and adult stroke patients did not show any difference in the use or non-use of constraint during task specific training [2,9,10]. Furthermore, in children, play is an important thing and constraining the upper limb for 10 hours for example, might interfere with their ability to play with the hand [1].

The data collection instruments used in this study were Pediatric Motor Activity Log (PMAL), Toddler Arm Use Test (TAUT), 10 cm Visual Analogue Scale and Goniometer. Whilst both PMAL and TAUT are measures of real world arm use, VAS is a measure of pain severity.

The PMAL was originally a 22 itemed semi structured interview which was adopted from adult Motor Activity log in patients with stroke [11]. It is used to measure real world arm use Its psychometric properties have been established. It has high internal consistency, inter-rater reliability and high test-retest reliability (r =0.94; P<0.01) [12]. In the present study, it was objectively administered on the children (they were asked to perform the tasks). TAUT is a standardized motor test that contains 21 series of tasks which are administered to the children [3]. It is used in measuring arm motor function. It is scored on a 6 point scale ranging from 0 to 5. The instrument has been reported to have inter-rater reliability of 0.98 [13]. Visual Analogue Scale is a 10 cm pain rating scale used to rate level of pain. It has good intra-rater reliability [14]; and is highly correlated with 5 point verbal descriptive scale and numeric rating scale [15]. In this study, the children were asked about the presence and severity of contralateral upper limb pain, and this was rated according to the 10 cm VAS scale by the authors.

The data at baseline and 2, and 4 weeks post intervention was tested for assumption of normality of distribution using a Q-Q plot. The data in all the 3 conditions were found to be around the plots' diagonals suggesting normal distribution. Therefore, a repeated measure analysis of variance (ANOVA) with Bonferoni adjusted post hoc analysis was used to analyze the data at baseline and 2, and 4 weeks post intervention on all the 3 outcomes measures (PMAL, TAUT and VAS).

Results

Twenty two children were screened for eligibility for inclusion in the study. See Figure 1 for the study chart flow. Out of this number, only 16 children with mean age of 7 years fulfilled the study inclusion criteria, and were thus included in the study. However, one of the children with hemiparesis due to sickle cell disease had bilateral hemiparesis, totaling the number of study participants to 17. The remaining 5 were excluded based on their age<3 years. In the included study participants, there were more girls (N=9) than boys (N=8). The aetiologies of their hemiparesis include sickle cell disease (N=4), cerebral palsy (N=3), head injury (N=3), cerebral malaria (N=3), cerebral meningitis (N=1), birth asphyxia (N=1), infantile hemiparesis (N=1) and neonatal jaundice (N=1). Mean time since hemiparesis was 40 months. See Table 1 for the characteristics of the included participants (Figure 1 and Table 1).

S/N	Age	Sex	Condition	Side affected	Time since hemiparesis
1	5 years	F	Birth asphyxia	Right	5 years
2	3 years	M	Cerebral Malaria	Right	2 Years
3	10 Years	M	Cerebral Malaria	Right	2 Years
4	4 years	F	Neonatal Jaundice	Right	11 Months
5	8 years	M	Sickle Cell Disease	Right	5 years
6	8 years	M	Sickle Cell Disease	Left	5 years
7	9 years	F	Head Injury	Left	4 years
8	9 years	F	Cerebral Palsy	Left	9 years
9	5 years	F	Meningitis	Right	4 years
10	4 Years	M	Cerebral Malaria	Right	4 Months
11	5 years	M	Sickle Cell Disease	Right	3 Months
12	6 Years	F	Infantile Hemiparesis	Right	6 years
13	11 Years	M	Head Injury	Right	3 years
14	11 Years	F	Sickle Cell Disease	Right	8 Months
15	4 Years	M	Cerebral Palsy	Right	5 Months
16	4 Years	F	Cerebral Palsy	Right	6 Months
17	11 Years	F	Head Injury	Right	8 years

Table 1: Characteristics of the study participants.

The results of the repeated measures ANOVA showed a significant effect for time (baseline and 2 and 4 weeks post intervention) for all the outcomes with the exception of pain level measured using VAS. Table 2 detailed all these information. For PMAL (AOU), there was a significant effect for time, Wilks Lambda =0.21, F (2, 17) = 28.89, P<0.005, multivariate partial eta squared= 0.79. Between baseline and 2 weeks post intervention, there was a significant difference in means (mean difference = -0.95, 95% CI = -1.46 to -0.45, p<0.05). Between baseline and 4 weeks post intervention, there was a significant difference in means (mean difference = -1.32, 95% CI = -1.88 to -0.75, p<0.05). Between 2 and 4 weeks post intervention, there was a

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significant difference with (mean difference = -0.36, 95% CI = -0.49 to -0.23, p<0.05).

Scale	Time Period	N	Mean ± SD	F	P-value
MAL (AOU)	Baseline	17	1.81 (0.87)	28.89	<0.05
	2 weeks post-intervention	17	2.77 (1.19)		
	4 weeks post-intervention	17	3.13 (1.23)		
MAL (QOU)	Baseline	17	1.89 (0.87)	30.73	<0.05
	2 weeks	17	3.00 (1.26)		
TAUT (AOP)	Baseline	17	0.96 (0.50)	29.77	<0.05
	2 weeks post-intervention	17	2.62 (1.18)		
	4 weeks post-intervention	17	1.29 (0.49		
	4 weeks post-intervention	17	1.50 (0.47)		
TAUT (QOU)	Baseline	17	1.54 (0.94)	21.58	<0.05
	2 weeks post-intervention	17	2.12 (1.14		
	4 weeks post-intervention	17	2.45 (1.08		
TAUT (Willingness)	Baseline	17	0.98 (0.54)	33.59	<0.05
	2 weeks post-intervention	17	1.51 (0.67)		
	4 weeks post-intervention	17	1.94 (0.70)		
Pain Level (10 cm VAS)	Baseline	17	2.00 (1.32)	4.74	0.025
	2 weeks post-intervention	17	1.82 (1.51)		
	4 weeks post-intervention	17	1.47 (1.55)		

Table 2: ANOVA Results for MAL (AOU), MAL (QOU), TAUT (AOP), TAUT (QOU), TAUT (Willingness) and Pain Level (10 cm VAS) at Baseline and 2 Weeks; and 4 Weeks Post-intervention.

For PMAL (QOU), there was also a significant effect for time, Wilks Lambda = 0.20, F (2, 17) = 30.74, P<0.005, multivariate partial eta squared=0.80. Between baseline and 2 weeks post intervention, there was a significant difference in means (mean difference = -0.74, 95% CI = -1.01 to -0.38, p<0.05). Between baseline and 4 weeks post intervention, there was a significant difference in means (mean difference = -1.12, 95% CI = -1.54 to -0.69, p<0.05). Between 2 and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.38, 95% CI = -0.51 to -0.24, p<0.05).

For TAUT (AOP), there was also a significant effect for time, Wilks Lambda = 0.20, F (2, 17) = 29.77, P<0.005, multivariate partial eta squared=0.79. Between baseline and 2 weeks post intervention, there was a significant difference in means (mean difference = -0.33, 95% CI = -0.52 to -0.15, p<0.05). Between baseline and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.54, 95% CI = -0.72 to -0.35, p<0.05). Between 2 and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.20, 95% CI = -0.33 to -0.76, p<0.002).

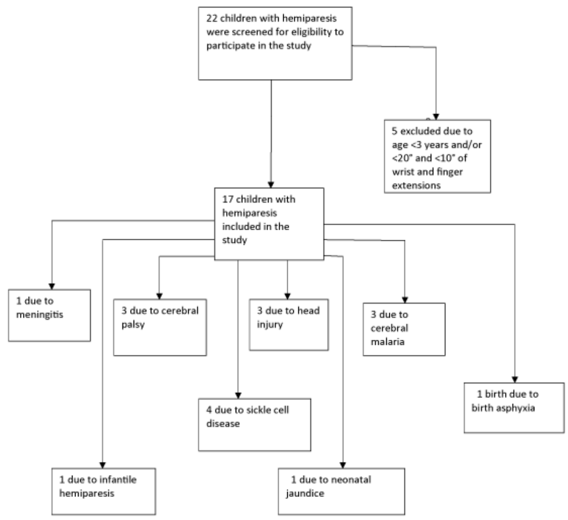

Figure 1: Study Flow Chart

For TAUT (QOU), there was also a significant effect for time, Wilks Lambda = 0.26, F (2, 17) = 21.58, P<0.005, Multivariate partial eta squared=0.74. Between baseline and 2 weeks post intervention, there was a significant difference in means (mean difference = -0.58, 95% CI = -0.85 to -0.30, p<0.05). Between baseline and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.91, 95% CI = -1.29 to -0.52, p<0.05). Between 2 and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.33, 95% CI = -0.66 to 0.00, p<0.05).

For TAUT (Willingness), there was also a significant effect for time, Wilks Lambda = 0.18, F (2, 17) = 33.59, P<0.005, multivariate partial eta squared = 0.82. Between baseline and 2 weeks post intervention, there was a significant difference in means (mean difference = -0.53, 95% CI = -0.75 to -0.31, p< 0.05). Between baseline and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.96, 95% CI = -1.26 to -0.65, p<0.05). Between 2 and 4 weeks post intervention, there was a significant difference in means (mean difference = -0.42, 95% CI = -0.64 to -0.21, p<0.05).

For Pain level (VAS 10 cm), there was no significant effect for time, Wilks Lambda = 0.61, F (2, 17) = 4.74, P>0.05, multivariate partial eta squared=0.39. Between baseline and 2 weeks post intervention, there was no significant difference in means (mean difference = 0.18, 95% CI = -0.24 to 0.59, p= 0.81). Between baseline and 4 weeks post intervention, there was a significant difference in means (mean difference = 0.53, 95% CI = 0.01 to 1.05, p<0.05). Between 2 and 4 weeks post intervention, there was a significant difference in means (mean difference = 0.35, 95% CI = 0.03 to 0.67, p<0.03).

Discussion

The aim of this study was to find out the feasibility and effectiveness of 300 repetitions of task practice per day during task specific training on motor function in children with hemiparesis; and that whether the task practice can be spread over sessions per day. Additionally, the study investigated whether this amount of repetitions would have any effect on upper limb pain.

The result of the study showed that there was a significant improvement in real world arm use and function, assessed using PMAL and TAUT at 2 and 4 weeks post intervention respectively. For pain, there was no significant difference in the level of pain between baseline and 2 and 4 weeks post intervention assessed using 10 cm VAS. The findings of the study on motor function are in agreement with 2 recent studies where adult stroke patients were reported to carry out task repetitions as high as 322 per session and 320 reps spread over 2 sessions per day respectively [5,6]. However, the former study was a case report of a single stroke patient and thus it is difficult to generalize its findings.

Unlike the present study, the above studies used ARAT and WMFT to assess motor function respectively. Additionally, the result from the study by Birkinmeier and colleagues did not attain minimal clinically important difference (MCID) values post-intervention, which are 12 and 17 points increase on ARAT for dominant and non-dominant hands respectively [16]. MCID is defined as the smallest difference in score in the domain of interest which patients perceive as beneficial and which will mandate, in the absence of troublesome side effects and excessive cost, a change in the patients management [17]. In contrast, in the present study, MCID values were attained from baseline to 2 weeks post intervention (+1.0) and baseline to 4 weeks post intervention (+1.3) on PMAL (AOU); and from baseline to 4 weeks (+1.1) on PMAL (QOU). These findings are similar to the ones by Taub et al. (2004) where they found +1.8, 1.3 and + 1.6 points increase on PMAL (AOU) at 3 weeks, 3 months and 6 months post intervention respectively, and +1.7, +1.7, and +1.8 on PMAL (QOU) at 3 weeks, 3 months and 6 months post intervention respectively after administering task practice for 6 hours each day for 21 days. Thus, the findings of the present study on motor function suggest the usefulness of using the number of repetitions of task practice as a good measure of dose that could replace the use of time spent practicing tasks as a measure of dose.

Another difference between the present study and previous ones by Brandao and colleagues, Taub and colleagues and Gordon and colleagues, is that same tasks were performed by the participants in the present study. This takes care of the variability in tasks practiced by participants during task specific training that could negatively affect the evidence for effectiveness. Furthermore, unlike the previous studies, the present study investigated whether high repetitions of task practice can cause upper limb pain. Pain in the upper limb can limit the ability to perform task practice [18] and this may limit motor recovery as high amount of task practice is required for neuroplasticity [19].

Conclusion

It may be feasible and effective for children to perform 300 repetitions of task practice spread over 3 sessions per day. Additionally, high repetitions of task practice may not cause upper limb pain in children with hemiparesis.

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