

Case Report

Outcome of individualized task related circuit training program on walking ability in a 9 years old female child with Moya-moya disease: a case report

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ABSTRACT

Walking difficulty of childhood stroke due to Moya-moya disease needs functional rehabilitation to recover to a normal state of walking. Task related circuit training program is one of the rehabilitation programs that improve functional strength of lower limb muscles to aid in improved walking ability. This case report aimed at investigating the effectiveness of task related circuit training on walking ability of a 9 years old female child diagnosed with stroke due to Moya-moya Disease. The child was attending Indoor rehabilitation services, Department of Occupational Therapy, National Institute for Locomotor Disabilities, Kolkata, West Bengal. Baseline measurement of the child's lower limb muscle strength, 10m walk test, 6-minute walk test was done prior to the circuit training. After baseline measurement, the child was explained the sequence of tasks to be used in circuit training and was given individualized task related circuit training for a session of 45 minutes, 3 days per week for 08 weeks. Post training the child showed improvement in lower limb muscle strength, 10m walk test (walking speed) and 6-minute walk test (walking endurance), thereby an improved walking ability.

Keywords: Endurance, Individualized task related circuit training, Moya-moya disease, Strength, Walking ability

INTRODUCTION

Moyamoya disease is a rare progressive vaso-occlusive disorder of an unknown etiology. It is characterized by progressive stenosis of terminal portions of internal carotid arteries bilaterally, and the main trunks of Anterior and Middle Cerebral Artery, and is associated with collateral vessels at the base of the brain ('Moyamoya' vessels).¹ Moyamoya was first described in Japan in the 1960s and, in Japanese, its name means "puff of smoke", which describes how the tangle of blocked arteries appear in an X-ray.² Although the disease is most common in Japan, many subsequent cases have been reported elsewhere, including North America, Europe, and India.³

Stroke in childhood is rare, with an incidence of approximately 2.5 to 2.7 cases per 100 000 per year.^{4,5} Pediatric stroke is an important cause of chronic morbidity in children and can leave a child with disabilities that span motor, cognitive, and behaviour functions.⁶ Moyamoya disease or syndrome is believed to be a rather uncommon cause of stroke in childhood.⁷

Primarily, Moyamoya affects children, with a stroke or recurrent transient ischemic attacks (TIA) appearing as the first symptom. These symptoms are often accompanied by paralysis affecting one side of the body, muscular weakness, or seizures.⁸ In children, Moyamoya disease or syndrome can present with either transient or permanent neurological deficits. Cerebral ischaemia

predominates in children. There can be a wide range of neurological presenting symptoms including motor deficits, sensory impairment, involuntary movements, headache, seizures, or cognitive impairment.²

The functional outcome of patients with Moyamoya is not well described in the literature. The patients with Moyamoya had a higher discharge Functional Independence Measure (FIM), longer length of stay, and slower rate of progress. Data on long-term survival and functional level would be useful, but it appears patients with Moyamoya disease may benefit from rehabilitation oriented toward neurological deficits.⁹ Muscle paresis or weakness is an important neurological deficit of stroke patients due to Moyamoya disease. Paretic muscle strength is related to a number of activities of daily living in individuals with stroke such as balance, walking speed, and walking endurance.¹⁰⁻¹³ Muscle strength has an important influence on functional walking capacity, and understanding the relationship between these two variables is critical to planning effective interventions to improve walking.¹⁴

Strength training is known to promote neural adaptations such as improved motor unit activation and synchronization of firing rates, which may deteriorate with periods of inactivity.¹⁵ Strength protocols may not be sufficient to transfer the strength gains to functional tasks without complementary task-specific practice.¹⁶ Task-specific training interventions that include components of graded muscle strength or muscle strengthening during functional tasks like circuit training have been shown to be effective in improving functional performance.¹⁷ Circuit training is a highly efficient form of training having many work stations. It improves strength and endurance by stressing aerobic and anaerobic system. Dean CM et al conducted a pilot study with chronic stroke, who participated in task related circuit training programme designed to improve strength and endurance of the affected lower limb and functional performance and the patients demonstrated significant improvement after training and also 2 months follow-up compared with the control group.¹⁷

Ambulatory function is important in day to day life and necessary for successful community participation. Therapeutic interventions for improving walking ability of Moyamoya affected children with stroke are not described in the literature. In this study an attempt has been made to investigate the effectiveness of an 8 weeks program of individualized task related circuit training programme on walking ability of a 9 years old girl child with stroke due to Moyamoya disease.

CASE REPORT

A 9 years old female child presented to the Ramakrishna Mission Seva Pratishan, Kolkata, West Bengal, India with sudden onset of aphasia, slurring of speech with difficulty in movement and eating using right hand on 13

June 2016. She was referred to NIMHANS. She was diagnosed to have Moyamoya disease by a Pediatric Neurosurgeon, NIMHANS, India. Patient underwent Left Superficial temporal artery and middle cerebral artery cortical branch anastomosis on 22 July 2016. She developed right upper limb and lower limb muscle weakness on post-operative day 2 which persisted since then. She was referred to Department of Occupational Therapy, National institute for Locomotor Disabilities (NILD), Kolkata on November 2016 for rehabilitation.

She presented to the department of Occupational Therapy, NILD, Kolkata, India with chief complain of weakness of right upper limb and lower limb, inability to walk normally and fatigue. The patient had no family history of stroke, seizure, or cancer.

On physical examination, the patient was conscious and oriented. On neurologic examination, the cranial nerves were normal. Muscle Power was decreased (3/5) in right upper and lower limb and the tone was decreased, superficial reflexes were absent and deep tendon reflexes were exaggerated in both right upper and lower limbs. She could not walk for long distances because of easy fatigue. The left side neurological examination was normal, and there were no signs of sensory or cerebellar dysfunction.

Prior to participation in the case report, the child signed an informed consent. The parents of the child also provided their consent for her participation. The child was evaluated for all the outcome measures before the training and 8 weeks after the individualized task-related circuit training. Outcome measures used were 1. Medical Research Council Manual Muscle Testing (MMT) to evaluate muscle strength of Hip flexors, extensors and abductors, Quadriceps, Hamstrings, Planter flexors and Dorsi-flexors, 10 Meter walk test, was used to measure gait speed and 6 Minute Walk Test (6MWT) was used to examine the subjects' walking endurance.^{19,20} All the tests were carried out on the same day, excluding the 6 minute Walk Test, which was done the next day to avoid the effects of fatigue on the subject.

The subject participated in the individualized task related circuit training program for a session of 45 minutes, 3 days per week, for 08 weeks. The circuit class was conducted in the clinic and the subject was instructed not to practice any of the tasks at home. The tasks were Sit to stand from appropriate seat height, stepping up and down, Stair climbing, Heel raise and lower, over ground forward walking, Walking sideways and Walking backward each for 5 minutes. Before starting of training program, the subject had 5 minutes of warm up and after the end of the training 5 minutes of cool down period. The warm up period included 3 minutes of stationary bicycling at a moderate pace and ended with 2 minutes of gentle stretching. The cool down period included stationary bicycling with relatively slow pace for 3 minutes and ended with a series of gentle stretch, holding each stretch

with at least 10-20 seconds. The results of the measurements taken post training are presented below.

MMT of hip flexors, extensors and abductors, Knee extensors and flexors, planter flexors and dorsi-flexors of Right lower limb improved by one grade or half a grade. Manual Muscle Testing (MMT) of right lower limb pre and post circuit training is shown in Table 1.

Table 1: MMT (MRC grading) of right lower extremity.

Muscle tested	Right (pre)	Right (post)
Hip flexors	3	4+
Hip extensors	3	4+
Hip abductors	3	4+
Knee extensors	3+	4+
Knee flexors	3	4
Ankle Dorsi flexors	3	4
Ankle planter- flexors	4	4+

Walking speed of the subject was increased from 30.92 cm per second to 41.25cm per second post task related circuit training. The distance walked by the subject was increased from 163.57meter to 229.92meter post task related circuit training. Improvement in walking speed (10MWT) and walking endurance (6MWT) is shown in Table 2.

Table 2: Ten-meter WT and 6MWT pre and post circuit training.

Outcome measure	Pre-treatment	Post-treatment
10 Meter WT	30.92	41.25
6MWT	163.57	229.92

DISCUSSION

The purpose of this case study was to see the effect of 08 weeks of task related circuit training on walking ability of a female child with stroke due to Moyamoya disease. Resistance training improves walking ability of stroke patients and added purpose to exercise or tasks, designed to improve strength can have a positive effect on walking ability in stroke hemiparesis. The result supports the efficacy of task-related circuit training for this patient. In this study, the task related practice (with at least body weight or weight of a limb as resistance), as in repeated standing up and sitting down, helped in increasing muscle strength of lower extremity (increased force generating capacity). Increased muscle strength occurs due to improved firing and synchronization of motor units and improved agonist antagonist and synergic coordination. Task related exercises have therefore the potential to increase the control of movement and functional performance of the everyday actions which are the focus of the exercise.²¹

The sit to stand task helped in improving muscle strength of Hip and knee extensors, Ankle Dorsiflexors and repeated sitting to standing helped in improving the length of the Soleus muscle.²² During ascent (stair climbing task) stance phase, weight acceptance is initiated with middle to front portion of foot, pull up occurs through the extensor activity at the knee, ankle, primarily concentric contraction of vastus lateralis and soleus and in forward continuance phase ankle generates forward and lift forces. In swing phase, foot clearance is activated through activation of dorsiflexors and activation of hamstrings which flex the knee. The Rectus femoris contracts eccentrically to reverse the motion by mid swing. The swing leg is brought up and forward through activation of hip flexors of the swing leg and motion of the contra lateral stance leg. Final foot placement is controlled by hip extensor and ankle dorsiflexor. Decent (walking down stairs) is achieved through eccentric contraction of Knee extensors and planter flexors.²² Step up and step-down task trains hip, knee and ankle extensors to work together both concentrically and eccentrically, to raise and lower the body mass. Step up exercises also train ankle dorsiflexors. Heel raise, and lower task helped in improving the planter flexor strength which is the major power generator during the gait cycle during push off.²³ The hip abductors improved in power due to side wise walking task and walking back ward task strengthens hip extensor activity particularly hamstring.^{24,25}

The patient had showed improvement in 6 minute walk test which may be due to increased Volume 2 Max as well as increased muscle strength and physical fitness after training which is reduced in patients with Moyamoya disease.²¹ This overall improvement in muscle strength, endurance and reduced fatigue helped in improving walking speed and the ability to walk after task related circuit training, which is supported by the study of Dean et al.²⁴ The increase in speed may be due to increase in strength of ankle planter flexor, hip extensor and flexors. Planter flexor and hip flexors is the major power generator for push up and pull-up during propulsion. There is increasing evidence that the effects produced by strengthening programs may generalize to higher gait speeds, increased gait endurance and improved Activities of daily living.²⁴⁻²⁶ Added purpose of task related circuit training can enhance performance compared to rote exercise.²⁷ In addition it found in other studies by Richards et al 1993, and Dean et al 2001 that training programs in which patients are subjected to high repetitions of functional activities are more likely to improve in function than conventional strengthening of lower limb.^{25,24} The concept of "young age plasticity privilege or the "Kennard-effect" that describes superior recovery of cognitive and motor skills after brain lesions in infant animals and humans compared to adults might be a reason for the improvement seen in this child.²⁸⁻³⁰

There were certain limitations of the study. As the tasks were common day to day activities, subject might have

used those tasks at home leading to improvement in some outcome measures. No follow up was done, so sustainability of the training effect could not be evaluated. A larger sample may be considered to investigate the effectiveness of the training programme in future.

CONCLUSION

The result of the study provides evidence, that task related circuit training can be used to improve the walking ability of childhood stroke subjects with Moyamoya disease. Use of tasks helped improving muscle strength of lower limb, walking speed and endurance thereby improving the walking ability of the subject.

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