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Effect of Kinesiotape in Improving Mobility Capacity in Children with Cerebral Palsy

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Abstract

Background: *The purpose of this study was to examine the effect of application of Kinesiotape over the thigh muscles in improving mobility capacity of children with cerebral palsy.*

Objective: *To find out the effect of kinesiotaping over the thigh muscular along with conventional occupational therapy in improving strengthen of muscles and to improve mobility capacity of children with cerebral palsy.*

Study Design: *Pre Test and Post Test experimental study design.*

Method: *Sixty children with cerebral palsy who were fulfilling the inclusion criteria were selected by convenient sampling from Occupational Therapy unit of Sir Sunderlal Hospital, Banaras Hindu University, Varanasi, Uttar Pradesh, India. A written informed consent and ethical permission was obtained. Hand-held dynamometer was used for measuring the strength of knee flexors and extensor.1-min walk test, 10-m walk Test, lateral-step-up and timed-stair test was used as instrument for measuring improvement in mobility capacity of these children. Therapy for both the groups was given for 1 hour per session. In the experimental group along with conventional occupational therapy, kinesiotape (KT) was applied over the knee flexor and extensor muscles.*

Results: *After the intervention, there was more improvement in experimental group as compared to the control in mobility capacity of children with cerebral palsy.*

Conclusion: *It can be concluded that application of kinesiotape along with conventional occupational therapy can be used to enhance & improve strengthen of knee flexors and extensors in children with cerebral palsy.*

Keywords: *Kinesiotape, cerebral palsy, strengthening, dynamometer.*

Introduction

Muscle weakness is a common impairment in children with cerebral palsy (Brown et al 1991, Damiano et al 1995b, Wiley and Damiano 1998). Weakness has been attributed to in complete recruitment or decreased motor unit discharge rates (Elder et al 2003, Rose and McGill 2005, Stackhouse et al 2005, Wiley and Damiano 1998), inappropriate coactivation of antagonist muscle groups (Elder et al 2003, Stackhouse et al 2005, Wiley and Damiano 1998), secondary myopathy (Friden and Lieber 2003, Lieber et al 2004, Rose et al 1994), and altered muscle physiology (Stackhouse et al 2005). Correlation studies have demonstrated that muscle strength is related to mobility capacity in children with cerebral palsy. Ross and Engsberg (2007) reported a moderate correlation between strength and walking speed (r = 0.61) but little correlation between spasticity and walking speed (r =0.19) in children with cerebral palsy who ambulate. Damiano et al (2001) also found moderate to high correlations between strength and mobility limitations (r = 0.70 to 0.83). Several uncontrolled trials have reported increases in strength after training in children with cerebral palsy and that increased strength can translate into improved mobility (Blundell et al 2003, Damiano and Abel 1998, Eagleton et al 2004, MacPhail and Kramer 1995, Morton et al 2005). A recent systematic review (Mockford and Caulton 2008) concluded that strength training was associated with moderate to large gains in both strength and mobility of children with cerebral palsy. Strengthening was defined broadly as repetitive effortful contractions of any muscle and therefore requires progressive resistance exercise for maintenance. KT method which was first described by Dr. Kenzo Kasein 1996 is used to increase sensory stimulation, strengthen the weak muscles, inhibit spastic muscles, increase joint stability, increase functional motor skills, help with postural control and improve functional independence in pediatric rehabilitation clinics in addition to the occupational therapy programs (Kase K et al 2006). This innovative taping application is based on eccentric stimulation of the skin, muscle tissue, tendons, neurological vessels, lymphatic and vascular pathways improving their functioning. Neuromuscular taping (NMT) provides passive stretching through the application of a tape with eccentrically properties encouraging flexibility and coordination and bettering range of movement in patients suffering with excessive muscle contraction due to different clinical conditions. It has been claimed that the effects may be due to the sensorimotor and proprioceptive feedback mechanisms. It has been hypothesized that the application of NMT is able to stimulate cutaneous mechanoceptors. These receptors activate nerve impulses when mechanical loads (touch, pressure, vibration, stretch and itch) create deformation. Their activation by an adequate stimulus causes local depolarization, which triggers nerve impulse along the afferent fibers travelling towards the central nervous system. However, few applications support the use of this type of tape to improve the upper-body functionality in CP. KT consists of noninvasive adhesive elastic taping, the purpose of which is to mechanically restrain pathological movements, to preserve functional movements at the same time, and to enhance perceptive feedbacks (Iosa M et al 2010).The purpose of this study is to find out that if kinesiotape is applied over the knee flexors and extensor muscles along with strengthening of these muscles it can improve mobility capacity in children with cerebral palsy.

Methodology

This study adhered to the tenets of Declaration of Helsinki guidelines. 60 children with medical diagnosis of cerebral palsy were enrolled in this study. The Ethical Committee of university approved our protocol. Inclusion criteria for the children with CP were age range 4 years to 8 years and being able to walk without (Gross Motor Function Classification System (GMFCS I and II) (Palisano R et al 1997) or with (GMFCS III) walking aids, and being able to follow verbal instructions. Children excluded from the study were those on Botox therapy (within the past 6 months) or muscle relaxants, those with active seizure disorders, those who had undergone any surgery for the lower limb, and those having allergic reaction to Kinesiotape. In all the subjects, lower limb spasticity was lower than 2 on the Modified Ashworth Scale and passive knee range of motion was full, with preserved ability to actively move the knee in flexion and extension.

The study purpose and test procedure were elaborately explained to the parents/guardians, after which written informed consent was obtained for their child's participation. A patch test with the Kinesio tape was performed on the dorsum of the hand (to confirm or rule out subject's allergy to Kinesio tape).

Experimentation

Isometric muscle strength was measured for flexors and extensors of knee using a hand-held dynamometer. The ''make test'' was used, in which the child pushes against the dynamometer for 3 s while maximally exerting force, while encouragement is given by the assessor. The highest value that was reached during the 3 s was registered. The tests were performed according to standardized procedures (Scholtes VA et al 2008) that showed acceptable reliability in children with CP (Willemse L et al 2013) HHD testing positions are described in Table 1. After one practice trial, the test was repeated three times for each muscle group.

Application of Kinesio tape

Tape application was performed in a quiet environment with each child's is being positioned comfortably on the chair. The skin was cleaned by Surgical Spirit 70% alcohol. Kinesio tape was applied over the muscles belly of hamstring on posterior part of the upper thigh to lower thigh using. "Y strap" technique. Semimemberanosus and semitendinous was covered by medial band from neck of femur to the tibia and biceps femories was covered by lateral band inserting at fibula. kinesiotape was applied to quadriceps muscles on anterior aspect form the upper thigh to lower thigh. I strap was applied to rectus femoris muscle belly. Y strap was applied over the vastus medialis and vastus lateralis. As shown in pictures 1 and 2. The Kinesio tape was kept over the child's thigh for 3 days. After 3 days KT was removed and area of application was left open for 24 hours. Then again it is applied for other 3 days. This sequence was carried out for a month.

Strengthening activities for flexors and extensors of knee

1. Static cycling with gradually increasing resistances.
2. Squat to stand activities.
3. Stair climbing activities
4. Kicking activities.
5. Strengthening with therabands and weight cuffs.

Mobility capacity

Mobility capacity was assessed as walking speed, using 1-min walk tests (m/s), 10-m walk (m/s) and sit-to-stand, lateral-step-up and timed stair test.

The 1-min walk test (McDowell BC et al 2005) was used to measure walking capacity, defined as maximal walking speed. The child was instructed to walk as fast as possible, without running, around an oval track for 1min. Distance (in meters) was measured to the nearest meter, and used to determine maximal walking speed (m/s).

The 10-m walk test was performed to assess self-selected walking speed, calculated from the time to walk 10 m, while the child was instructed to walk at comfortable speed. The test was performed with a ''flying start'' on straight and flat surface. (Wade DT et al 1992).

The sit-to-stand test assesses the number of repetitions that the child can perform in 30 s (Verschuren O et al 2008) when getting-up from a chair seat to stand. The test was done on child-sized chair with a height adaptable seat.

The lateral step-up test assesses the number of step ups that the child can perform in 30 s on a 21 cm step placed lateral to the child, with the most impaired (CP) or no preferred (TD) leg on the step. The child was asked to put the foot of the tested leg on the step, and to fully extend the knee and hip of the leg for each repetition (Verschuren O et al 2008).

The Timed-stair test assesses the time needed to go up and down a 5-step set of stairs with handrails on both sides and the time needed to go up a 12-step set of stairs (Scholtes VA et al 2008)

Results

A total of 60 children participated in the study; these children were divided into 2 groups 30 in each group. 35 children walked without walking aids (GMFCS I and II) and 25 children were dependent on walking aids (GMFCS III). Characteristics of the participants of both groups are shown in Table 2. It shows that the mean age and standard deviation of children with cerebral palsy participated in the study with age range of 4-8 years with mean age of 6.25 years ± 1.63 in experimental group. In control group age range of 5-8 years with mean age of 6.35 ± 2.08 years. Mean height in experimental group is 140.5 (9.8) and in control group is 141.8 (14.9). The mean and standard deviation of Body mass is 34.5±7.57 in experimental group and 37.7±12.25 in control group. There were 19 males and 11 females in experimental group and 16 male and 14 female in control group. There were 13 in GMFM I, 11 in GMFM II &16 in GMFM III in experimental group. In control group there were 17 in GMFM I, 8 in GMFM II and 5 in GMFM III. In experimental group 8 were unilaterally involved and 22 bilaterally involved, in control group unilateral 6 and bilateral 24. Table 3 Mean age and standard deviation of strengthen for knee flexors before and after intervention in experimental group was 7.24 ±0.18 and 8.25±0.19 and for knee extensors it was 4.36 ± 0.12 and 5.46 ± 0.24 for control group. Table 4 shows the improvement in mean and standard deviation for the mobility capacity tests in experimental and control group. In 1 minute walk test it was 1.97 ±0.18 and 1.36 ±0.44 in experimental and control group respectively. For 10 meter walk test it was 1.41 ± 0.22 and 0.95 ± 0.28 in experimental and control group respectively. In sit to stand test experimental and control group had mean and standard deviation of 20.87 ± 2.28 and 11.88 ± 3.05 respectively. For lateral step up test 30.47 ±3.98 and 14.84 ± 4.90 were the mean and standard of experimental and control group. In timed stair test experimental and control group had mean and standard deviation of 6.32 ± 5.07 and 5.67 ± 3.56 respectively. For timed stair test N experimental group had mean of 2.67 ± 0.76 and control group had 1.91 ± 0.63.

Figure 1 showing application of kinesiotape in anterior thigh. Y straps for vastas lateralis & vastas medialis. I strap for rectus femorier

Figure 2 showing application of kinesiotape in posterior thigh. Y straps for semimembinous & semitendinonus.

Table 1 Isometric muscle strength testing: protocol for child positioning, joint positioning and dynamometer resistance

Muscle group	Position	Joint positions	Position dynamometer
Knee extensors	Sitting	Knee flexed 90	Anterior tibia, 5 cm proximal to malleoli
Knee flexors	Sitting	Knee flexed 90	Posterior calf, 5 cm proximal to malleoli

Table 2 Subject characteristics, group mean and standard deviation (SD).

Group	n	Age (years) Age range	Height (cm)	Body mass (kg)	Sex (boy/girl)	GMFCS (I/II/III)	Involvement(unilateral/bilateral)
Experimental	30	4-8 years 6.52 (1.63)	140.5 (9.8)	34.5 (7.57)	19/11	13/11/6	8/22
Control	30	5-8 years 6.35(2.08)	141.8 (14.9)	37.7 (12.25)	16/14	17/8/5	6/24

Table 3 Mean and standard deviation of strength of the knee flexor and extensor muscles before and after therapy

Group	Knee flexor (N/kg) before	Knee flexor (N/kg) after	Knee extensor (N/kg) before	Knee extensor (N/kg) after
Experimental	7.24 ± 0.18	8.25 ± 0.19	4.36 ± 0.12	5.46 ± 24
Control	5.24 ± 0.18	5.46 ± 24	3.09 ± 0.18	4.46 ± 24

Table 4 Improvement in Mean and standard deviation (SD) for the mobility capacity tests

Group	1-min walk (m/s) Mean (SD)	10-m walk (m/s)	Sit-to-stand (# repetitions)	Lateral step-up (# steps)	Timed stair test (s)	Timed stair test LN(s)a
Experimental	1.97 (0.18)	1.41 (0.22)	20.87 (2.28)	30.47 (3.98)	6.32 (5.07)	2.76(0.76)
Control	1.36 (0.44)	0.95 (0.28)	11.88 (3.05)	14.84 (4.90)	5.67(3.56)	1.91 (0.63)

Table 5 Results of Wilcoxon Signed Rank Tests 1-min walk (m/s)

Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value Lower limit	upper limit
Experimental	-2.87	0.004	8.98	11.12
Control	-2.44	0.014	7.04	9.51

Table 6 Results of Wilcoxon Signed Rank Tests 10-m walk (m/s)

Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value Lower limit	upper limit
Experimental	-2.16	0.36	6.36	7.38
Control	-2.72	0.32	6.08	8.01

Table 7 Results of Wilcoxon Signed Rank Tests Sit-to-stand

Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value Lower limit	upper limit
Experimental	-2.02	0.22	7.02	8.32
Control	-2.76	0.45	6.36	7.03

Table 8 Results of Wilcoxon Signed Rank Tests Lateral step-up

Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value Lower limit	upper limit
Experimental	-2.82	0.27	6.02	7.22
Control	-2.52	0.25	7.36	8.07

Table 9 Results of Wilcoxon Signed Rank Tests Timed stair test

Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value Lower limit	upper limit
Experimental	-2.50	0.25	5.16	7.07
Control	-2.42	0.15	7.86	8.17

Table 10 Results of Wilcoxon Signed Rank Tests Timed stair test

Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value Lower limit	upper limit
Experimental	-2.53	0.27	5.11	6.07
Control	-2.70	0.21	6.17	7.04

Discussion

This paper investigates the effect of kinesiotape over the muscle belly of quadriceps and hamstring muscles in mobility capacity of children with cerebral palsy. The results suggest that the Kinesio tape may improve mobility capacity in children with CP. Kinesiotaping enhances the kinesthetic inputs and facilitates enhanced control in the knee muscles to improve volitional control of the muscle and tendon movement during walking, thereby improving the control of lower limbs and movement of knee joint, so improving mobility capacity (Yasukawa A et al 2006). We assume that extension of the tape from upper thigh to knee on anterior and posterior aspect of thigh might have enhanced knee stability, which probably would have improved knee and lower limb muscle activity, hence facilitating better lower extremity movement and function (Kase K et al 2003). Because the tape was retained for a month over the involved lower limb of children with CP, we assume that the anticipatory control due to the presence of the tape over the knee and thigh muscles would have induced better muscular coordination and hence improved lower limb motor skills and mobility capacity. Because the kinesiotape was applied over the thigh muscles starting from their origin and extended up to the lower part of thigh till the insertion of muscles, covering the thigh and some parts of knee, we believe that such techniques would have provided improved stability. This would have facilitated clinically positive changes in the lower limbs motor functions and mobility capacity. This comes in consistent with Murray et al in 2005, who reported that neuromuscular tapping as an adjunct to the therapeutic procedures can improve strength, functional activities, proprioception, control and positioning. KT increases blood circulation in the taped area (Ogura1998; Oliveria 1999; Vorhies 1999; Wallis 1999; Kase 1994; Kase and Hashimoto 2005; Murray 2005), and this physiological change may affect the muscle and myofascia functions after the application of neuromuscular tapping helping the children to generate the necessary force required for the function. An additional theory is that neuromuscular tapping stimulates sensory receptors and cutaneous mechanoreceptors at the taped area. Cutaneous mechanoreceptors activate nerve impulses when mechanical loads create deformation. The activation of cutaneous mechanoreceptors by an adequate stimulus causes local depolarizations that trigger nerve impulses along the afferent fiber traveling toward the central nervous system (Garcia 2001; Goo 2001; Halseth et al. 2004; Maruko 1999; Mori 2001; Murray and Husk 2001; Ogura1998; Vorhies 1999; Wallis 1999; Kase et al. 2003). The application of KT may apply pressure to the skin or stretch the skin, and this external load may stimulate cutaneous mechanoreceptors causing physiological changes in the taped area. Studies previously conducted to determine the effects of neuromuscular tapping on cutaneous mechanoreceptors (Garcia 2001; Goo 2001; Halseth et al. 2004; Maruko 1999; Mori 2001; Murray and Husk 2001; Ogura 1998; Vorhies 1999; Wallis 1999) have reported that neuromuscular tapping on select muscles and joints may improved muscle excitability. There is no study in the literature investigating the use of neuromuscular tape application over the flexors and extensors of knee in improving mobility capacity of children with cerebral palsy.

Conclusion

It can be concluded that application of kinesiotape along with conventional occupational therapy can enhance and improve mobility capacity of children with cerebral palsy, so that they can have the independence of mobility, to safely meet demands of everyday life.

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