The Scientific Temper
Vol. 13, No. 2, July-December, 2022:pp 302-308
ISSN 0976-8653, E-ISSN 2231-6396
A Web of Science Journal
DOI: https://doi.org/10.58414/SCIENTIFICTEMPER.13.2.2022.302-308
Doc ID: https://connectjournals.com/03960.2022.13.2.302

Kinesio Taping Along with PNF Stretching Improved Ankle Dorsiflexion in Children with Spastic Diplegic Cerebral Palsy

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ABSTRACT

Brain damage that can occur before, during, or after delivery combined with permanent movement and postural deficit results in cerebral palsy (CP). CP affects physical characteristics like limbs, physiological and mental processes, as well as actions like standing and walking (e.g., sports). These shortcomings ultimately result in a number of disabilities, including deficits, restricted movement, and participation. Kinesio taping (KT) is a relatively new therapeutic technique used in the rehabilitation facility for children with cerebral palsy, however, it has been used for a long time in the sports or orthopedic domains and has been approved as adjuvant therapy for another functional handicap. Comparing CP treatment with PNF strength, PNF stretch, and PNF stretch alone will help spastic diplegic patients receive better care. The participants from the OPD and pediatric physiotherapy department of Shri Guru Ram Rai Institute of Medical and Health Sciences & Shri Mahant Indresh Hospital, Patel Nagar, Dehradun, were randomly split into two groups, with one receiving PNF stretching and the other receiving Kinesio-taping (n = 15 in each group). The interventions were given to both groups three days a week for a total of 12 weeks. Kinesio-taping along with PNF and PNF stretching alone both showed improvement in ankle dorsiflexion in spastic diplegic children but Kinesio-taping along with PNF showed more improvement in ankle dorsiflexion function in reducing calf muscle tightness and also improve walking pattern of the child after 12 weeks of intervention.

Keywords: PNF (Proprioceptive Neuromuscular Facilitation), MI (Modified Inclinometer), KT (Kinesio Taping), CP (Cerebral Palsy), and MAS (Modified Ashworth Scale).

INTRODUCTION

A neurological non-progressive condition called cerebral palsy (CP) is caused by brain injury that can happen before, during, or after childbirth coupled with a lifelong mobility and posture impairment **(Kalantari, et al., 2010; Amirsalari, et al., 2011; Shamsoddini, et al., 2014)**. It is the most prevalent movement condition linked to permanent impairment and the motor deficiency **(Aisen, et al., 2011)**. The international classification of functioning system (ICF) states that CP impacts bodily structures, such as limbs, physiological functions, and intellectual function, and activities, such as walking and standing and involvement (e.g., sports). These deficiencies ultimately cause certain impairments, such as deficits, limited mobility, and participation restrictions **(Novak, et al., 2013)**. Children with cerebral palsy (CP) who experience psychomotor abnormalities have limited limb use, increased paralysis, difficulties executing daily living activities, increased dependency, and ultimately a worse quality of life. As a result, it's critical that the therapy is given promptly and effectively **(Steultjens, et al., 2003; Kalantari, et al., 2013)**. Though it has been employed for a long time in the sports or orthopedic areas and has been authorized as adjuvant therapy for other functional disabilities, Kinesio taping (KT) is a comparatively recent therapeutic method employed in the rehabilitation facility

of children who have cerebral **palsy (Yasukawa, et al., 2006; Shamsoddini, et al., 2010a; Rasti, et al., 2016)**. Kinesio tape is a unique stretchy tape intended to simulate the flexibility features of the muscles, skin, and fascia. It is constructed of latex-free cotton fibers and has no medicinal effects **(Shamsoddini, et al., 2010b; Taylor, et al., 2014)**. When properly applied, the flexibility of the tape not only prevents soft tissue from being constrained but also supports weak muscles and expands the range of motion (ROM). Given that these receptors are linked to discomfort, proprioception, and motor control, it has been theorized that KT may advantageously activate these coetaneous receptors of the peripheral sensorimotor system **(McGlone, et al., 2010)**. It has been reported that KT can successfully affect the skin, facia, muscle, joints, the circulatory system as well as the lymphatic system to enhance proprioception, relieve pain, and muscle spasms, strengthen muscles and edema sufferings **(Mackin, et al., 2003; Jaraczewska, et al., 2006; Shamsoddini, et al., 2006; Kuo, et al., 2013)**. By adjusting muscle function, regaining proprioception, enhancing postural alignment, and activating coetaneous receptors, KT supports the joints. In addition to providing proprioception input for obtaining and keeping proper body posture, it can also lessen discomfort **(Shamsoddini, et al., 2010a;** ŞŞimşşeket **al., 2011; da Costa, et al., 2013; Shamsoddini, et al., 2013)**. Children with CP may benefit from KT treatment when combined with other normal rehabilitation programs since it may have a good effect on the sensorimotor system, leading to better conscious coordination and control of the upper limbs **(SHAMS, et al., 2006; Yasukawa, et al., 2006; Shamsoddini, et al., 2010b; Shamsoddini, et al., 2013)**.

This study aims to enhance CP therapy for spastic diplegic patients when compared to PNF strength, PNF stretch, and PNF stretch by itself. The purpose is to demonstrate the value of Kinesio taping and PNF stretch in combination, as opposed to PNF, stretch alone in improving ankle dorsiflexion range of motion in children with spastic diplegic cerebral palsy. Also, this study focuses to understand if PNF stretch alone is more helpful than PNF stretch combined in improving ankle dorsiflexion range of motion in spastic diplegic cerebral palsy children.

MATERIAL AND METHODS

Sample collection

30 children were selected from the OPD and pediatric physiotherapy department of Shri Guru Ram Rai Institute of Medical and Health Sciences & Shri Mahant Indresh Hospital, Patel Nagar, Dehradun.

Inclusion Criteria

Girls and boys between the ages of three and seven were included. Children were identified as having spastic diplegic cerebral palsy. Those who are capable of following MASinstructions are subjected and the three Grade is also considered within the inclusion criteria.

Exclusion Criteria

Frequent seizure sufferers in children, Injections of botulinum toxin, intellectual impairment, learning disability, and/or a history of medical treatments likely to disrupt motor functioning Orthopaedic corrective surgery, antispasmodic medication treatment, The affected arm, and hand were not found to have any wounds, rashes, allergies, or edema.

Materials used

The following items were used: a consent form, an assessment form, a pen, paper, a therapy mat, a modified inclinometer, a ROM chart, a MAS scale, a scissor, Kinesiotape, toys, and sanitizer.

Study Design

According to the inclusion criteria, only spastic diplegic CP children were randomly separated into two groups, i.e., group A and group B. With the aid of MAS and MI, the patient is evaluated. On the first day before the intervention (baseline values) and 12 weeks after the intervention, outcome measures such as the MAS and MI were assessed. The participants were divided into two groups at random: one group received Kinesio-taping with PNF method (n = 15), while the other received PNF stretching (n = 15). For a period of 12 weeks, both groups got interventions three days each week.

PNF stretching

Hold Relax: This method is quite similar to Contract Relax. When the agonist is too mild to function correctly, this is used. After stretching the patient's constricted muscle, the restricted muscle is isometrically contracted. The most well-known hold-relax antagonist. It may be used to extend out tight muscles and improve the passive range of motion. In this strategy, the tight muscle functions as the antagonist, causing the agonist to contract (provided that the agonist is strong enough). For manual stretching, the therapist instructs the client to isometrically contract the agonist: Manual stretching was carried out using an external force that was applied beyond the tissue's point of resistance and its range of motion and was held for between 30 and 60 seconds.

The distal portion was stretched while the proximal section was securely secured. Physical stretching involved

progressively moving the extremity through its range of motion until tissue limitation was reached. The stretching force was delivered slowly, with modest intensity, and within the range of the muscle. The stretching action was also in the reverse way of the line of pull. After holding the stretch posture for 30 to 60 seconds, the stretch tension was progressively removed.

Tendo Achilles

Using his left hand, the therapist flexes the knee while holding the lower thigh area. Holding the heel in a neutral stance is the therapist's right hand. With the right hand's dorsiflexion, the heel is flexed as the left hand gradually extends the knee.

Kinesio Taping

Child in a supine position

As the patient's foot rests on the ground, therapists softly bend the knee. Before placing the tape, the skin region of the tapping was washed with water, dried, or treated with an organic solvent. One step is made from the center of the dorsal part of the foot to the apex of the patella to aid the dorsiflexion action. Rub over the tape after applying it.

Child in a prone laying posture

The taping region was cleansed before the tape was applied by the therapists, who passively bend the knee and place the foot on the ground. The youngster was given I strap that was ready. The calf muscle was stretched to its fullest extent before the distance between the tendon and the knee crease was recorded. Due to the stretching effect of Kinesio taping, the length of the tape was reduced by half in accordance with the observed distance.

With very little strain imparted to the initial tape length, Y strap was placed from insertion to origin [from the tendoachillis to the origin of the soleus muscle and gastronemis]. Rub over the tape after applying it.

RESULT AND DISCUSSION

To help children with spastic diplegic CP develop ankle dorsiflexion, the planned study would evaluate the efficacy of Kinesio taping with PNF to PNF stretch alone **(Figure 1, Figure 2, Figure 3, Figure 4)**. In Patel Nagar, Dehradun's Shri Mahant Indresh Hospital, the study was conducted. These trials involved 30 patients with CP and spastic diplegia who had been diagnosed. First, a PNF stretching group with Kinesiotaping (n = 15) and second, a PNF group with random assignment (n = 15) were given to the participants **(Table 1)**. Three days per week for a total of 12 weeks were spent on interventions with both groups. At the beginning and one week into the intervention, evaluations were conducted twice.

When group A's pre-treatment mean and standard error of mean (28.13 ± 1.032) were compared to group A's posttreatment mean and standard error of mean (15.13 ± 0.994), analysis of MI showed a significant difference. When comparing group B's post-treatment mean and standard error of mean (25.53 ± 1.023) to group B's pre-treatment mean and standard error of mean (28.67 ± 1.023), MI analysis showed a marginally significant change. When MI was analyzed in groups A and B, there were substantial differences in both groups, however, group A's results are marginally more significant **(Figure 5)**.

There was a significant difference in group A, i.e., group A exhibited better improvement when treated with PNF and Kinesio-taping, when post-MI data of both groups A and B were analyzed. Group A Mean and SEM (15.13 ± 0.994), Group B Mean & amp; SEM (25.53 ± 1.023), respectively. By comparing group A's mean and standard error of mean (0.6000 ± 0.1309) from before treatment to group A's mean and standard error of mean (2.600 ± 0.1309), MAS analysis showed a significant change **(Table 2)**. Comparing group B's mean and standard error of mean (1.867 ± 0.1652) after therapy to group B's mean and standard error of mean (2.467 ± 0.1333) before treatment showed a significant change, according to the analysis of the MAS **(Table 3)**.

Group A exhibits somewhat higher significance in the results of the MAS analysis as compared to group B **(Table 4)**. Both groups significantly differed from one another. There was a substantial improvement in group A, i.e., group A exhibited better improvement when treated with PNF and Kinesio taping when post-data of MAS from both groups A and B were analyzed **(Figure 6)**. Group A Mean & SEM (0.6000 ± 0.1309), group B Mean and SEM (1.867 ± 0.1652) Although there is a considerable difference between the two groups' data after analysis, group A exhibits more progress, and when MI and MAS, the end measures, are compared, they provide the same conclusion **(Figure 7)**. In light of these findings, it is likely that the patient will progress more following four weeks of PNF plus Kinesio-taping treatment than they would with PNF alone.

Table 1: List of Patients treated with PNF Stretching and Kinesio Taping.

S.No.	Patient Numbers/ Identities	PNF Stretching	Kinesio Taping
1	Patient Number 1	+	–
2	Patient Number 2	+	–
3	Patient Number 3	+	+
4	Patient Number 4	+	+

5	Patient Number 5	+	+
6	Patient Number 6	+	−
7	Patient Number 7	+	−
8	Patient Number 8	+	−
9	Patient Number 9	+	+
10	Patient Number 10	+	−
11	Patient Number 11	+	+
12	Patient Number 12	+	+
13	Patient Number 13	+	−
14	Patient Number 14	+	+
15	Patient Number 15	+	+
16	Patient Number 16	+	−
17	Patient Number 17	+	+
18	Patient Number 18	+	+
19	Patient Number 19	+	−
20	Patient Number 20	+	+
21	Patient Number 21	+	+
22	Patient Number 22	+	−
23	Patient Number 23	+	−
24	Patient Number 24	+	+
25	Patient Number 25	+	−
26	Patient Number 26	+	−
27	Patient Number 27	+	+
28	Patient Number 28	+	−
29	Patient Number 29	+	+
30	Patient Number 30	+	−

+ = Patient treated with respective treatment therapy;− = Patient does not treat with respective treatment therapy.

Table 2: Comparison of the outcome measure within group A.

S.No.	Outcome Measure	Pre (Mean ± SEM)	Post (Mean ± SEM)	P value
1	MI	28.13 ± 1.032	15.13 ± 0.994	P < 0.0001
2	MAS	2.600 ± 0.1309	0.6000 ± 0.1309	P < 0.001

Table 3: Comparison of the outcome measure within group B.

S.No.	Outcome Measure	Pre (Mean ± SEM)	Post (Mean ± SEM)	P value
1	MI	28.67 ± 0.8489	25.53 ± 1.023	P < 0.0001
2	MAS	2.467 ± 0.1333	1.867 ± 0.1652	P < 0.0025

Table 4: Comparison of the outcome measure within group A and group B.

S.No.	Outcome Measure	Group A Post Data (Mean ± SEM)	Group B Post Data (Mean ± SEM)	P value
1	MI	15.13 ± 0.994	25.53 ± 1.023	P < 0.0001
2	MAS	0.6000 ± 0.1309	1.867 ± 0.1652	P < 0.0001

Figure 1: Toys use in Physiotherapy exercises

Figure 2: Group A Kinesio-Taping I Strap

Figure 3: Group A Kinesio-Taping Y Strap

Figure 4: Group B Contract Relax and Hold Relax

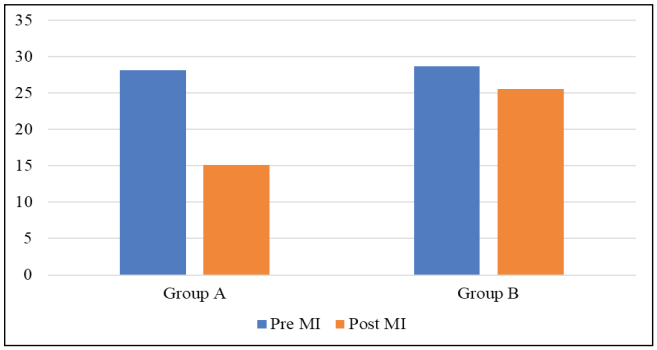

Figure 5: Group A and Group B pre- and post-MI comparison.

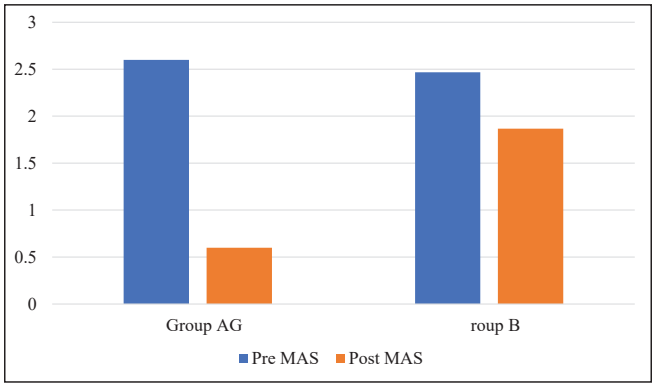

Figure 6. Group A and Group B pre- and post-MAS comparison.

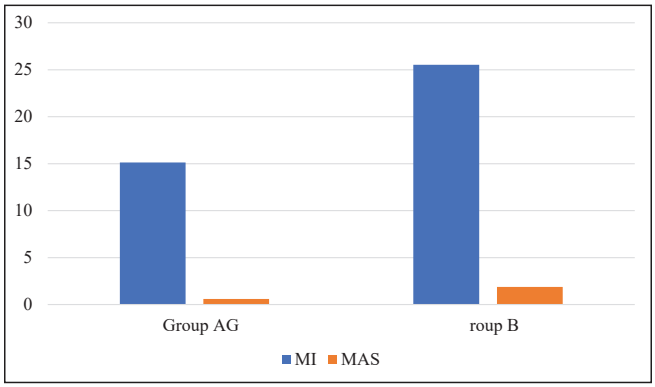

Figure 7. Group A and Group Bpost-MI and MAS comparison

In children with CP who have better functionality, kinesiology taping is an effective addition to physiotherapy treatments. Furthermore, all available data is insufficient, thus more investigation into lower extremity application techniques is advised **(Scheepers, et al., 2018)**. Children with CP who had Kinesio tape applied to their lower limbs had better balance. As a result, this technique may be applied in rehab facilities to help children with cerebral palsy become more functioning **(Tabatabaee, et al., 2019)**. The use of KT in CP patients shows beneficial effects in regard to enhancing trunk and lower limb functioning. It appears that this occurs more frequently soon after removal rather than very away after application. Further, significantly higher outcomes are seen when KT is combined with certain other physiotherapy therapies **(Tsimerakis, et al., 2021)**. Physiotherapists employ a variety of strategies and ways to battle the devastating impact that cerebral palsy has on a child's movement and, eventually, on their ability to function. Certain of them include traditional, tried-and-true techniques, such as Bobath, Vojta, PNF, and Katona, whereas combination-selective treatment, which tries to combine techniques rather than using monotherapy, has gained popularity recently. When compared to pre-intervention values, the ankle foot orthosis and combination taping groups significantly improved walking speed, step length, stride length, right single support duration, and left single support duration. Additionally, the post-intervention values of the double support time for the ankle foot orthosis and combination taping groups were considerably shorter than the pre-intervention values. For all measures, there were no appreciable changes between the ankle foot orthosis and combination taping groups' post-intervention results **(Ghafar, et al., 2021)**. The single leg and the attachment of the leg were both wrapped in Kinesio tape. Kinesio tape has an immediate impact on the development of motor skills in children when used in conjunction with a physiotherapy program that uses mirror cell stimulation to improve motor skills. Spastic diplegia cerebral palsy, however, there was no discernible distinction between the two groups statistically. The Kinésio Taping® approach interfered with the participants' spasticity and tibiotarsal range of motion, even though they didn't show any inclination toward the procedure **(Pina, et al., 2022)**. Numerous physiological processes which are unrelated to the CNS's motor function are significantly affected by the Kinesiotaping approach. The effects of the tape technique are long-lasting and are fixed by modifications to the CNS's function over a protracted period of time (at least 3–6 months). The ability to dynamically monitor patients over an extended period of time to determine the method's

efficacy is made possible by introducing Kinesiotaping to families of children suffering from cerebral palsy **(Kiselev, et al., 2022)**.

The majority of children with Spastic Diplegic CP walk on their toes because their calf muscles are tight, causing their feet to plantar flex. Kinesiotaping and PNF are two potential methods for rehabilitating children with cerebral palsy who have trouble walking. The current study's objective is to determine which therapy is more successful in increasing ankle dorsiflexion range. In this study, 30 kids were enrolled, and 15 kids were split between the two groups. The study measures the range of ankle dorsiflexion both before and after therapy with MAS and MI. Kinesiotaping and PNF, as well as PNF alone, were directly compared in this study. Both groups' pre- and post-test data were analyzed using the "t" test. Both therapy interventions were significant in improving the dorsiflexion ankle range in both the group that exhibited significant pre- and post-treatment differences, whereas Kinesiotaping in conjunction with PNF demonstrated more improvement. This information leads us to embrace the alternative hypothesis while rejecting the null hypothesis. This study thus adds to the body of evidence supporting the use of PNF and Kinesio-aping to increase ankle dorsiflexion in diplegic children with Spastic CP.

Because the trial was shorter in duration, no additional prognosis or long-term benefit could be reported. The sample size was so little. The COVID-19 Pandemic prevented proper follow-up from being done. This study focused only on ankle function. It is advised to do further research to lessen this restriction and study a bigger sample size of people of both sexes and children of different ages. The study period may last longer. Functional independence can be better recorded using a variety of outcome measures. The research can be conducted to observe the overall improvement of the lower extremities.

Declaration: *We also declare that all ethical guidelines have been followed during this work and there is no conflict of interest among authors.*

CONCLUSION

In this study, two methods for approaching the way of treatment were explored, PNF stretching and Kinesio Taping. Both approaches are known for their respective benefits as per the previous study. This study clearly depicts the beneficial effects resulting from the employment of these methods but when given as adjuvant therapy by combining the two methods, the resulting data was promising when compared to PNF stretching alone. Both PNF stretching alone and PNF stretching combined with Kinesiotaping improved the ankle dorsiflexion function in spastic diplegic children, however after 12 weeks of intervention, Kinesiotaping combined with PNF improved the child's walking pattern and reduced calf muscle tension. The data results are clear but the patient size used for this study was not very sizeable. In future studies, the results from this study can be explored by increasing the patient size and considering more variables that have not been explored yet.

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