

Effect of Kinesiotape versus Resistive Exercise on Dorsiflexors Functional Performance in Diabetic Peripheral Neuropathy

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Abstract

Background: Diabetic peripheral neuropathies are a heterogeneous group of disorders caused by neuronal dysfunction in patients with diabetes. DPNs cause different pathological changes in sensory, Motor and Function levels in Diabetic patients.

Aim of Study: Was to investigate the effect of Kinesio tape and resistive exercise on dorsiflexors' functional performance in diabetic patients with peripheral neuropathy and compare between them.

Subjects and Methods: Forty Type II diabetic patients-controlled-diagnosed by Physician and confirmed by Laboratory investigations (HbA1c, FBG) with Mild DPNs, their ages from 50-60 years old were assigned to two equal Groups (Group A) was treated with resistive exercise for eight weeks, three times per week. And (Group B) who were treated with KinesioTM tape that was applied to dorsiflexors 24 hours a day and was replaced every 5 days for 8 weeks. For evaluation of the muscle strength Hand held Dynamometer were used (Lafayette Manual Muscle Tester, Model #01163), while the functional performance was evaluated using the 6 minutes walking test.

Results: In Group A the mean value of muscle strength of the right dorsiflexors improved from (295.4 ± 84.7) to (334.5 ± 104.0) with the mean difference (39.2 ± 63.2) which is a significant difference. The mean value of muscle strength of the left side improved from (296.2 ± 115.2) to (310.8 ± 111.1) with the mean difference (14.7 ± 68.8) which is not a significant difference. The mean value of functional performance improved from (345.6 ± 62.8) to (376.4 ± 70.9) with the mean difference (30.7 ± 31.8) which is a significant difference. In Group (B) the mean value of muscle strength of the right side improved from (296.1 ± 66.8) to (385.5 ± 102.5) with the mean difference (89.4 ± 78.0) which is a significant difference, the mean value of muscle strength of the left side improved from (293.5 ± 72.8) to (385.5 ± 102.5) with the mean difference (89.4 ± 78.0) which is a significant difference and the mean

value of functional performance improved from (344.1 ± 73.2) to (388.4 ± 84.7) with the mean difference (44.3 ± 38.8) which is a significant difference.

In Conclusion: Both KinesioTM tape and resistive exercise improve the dorsiflexors and functional performance without significant difference between them on Dorsiflexors' strength and patients functional performance in diabetic polyneuropathy.

Key Words: Diabetic polyneuropathy – Hand-held dynamometer – 6 minutes walking test – KinesioTM tape – Glycosylated hemoglobin – Fasting blood glucose.

Introduction

DIABETES is a major health issue that has reached alarming levels: Today, nearly half a billion people are living with diabetes worldwide [1]. One of the primary causes of neuropathy [2]. The most common clinical form of diabetic neuropathy is Distal Symmetrical Polyneuropathy (DSPN), influencing more than 90% of patients. Typically, DSPN affects the toes and distal foot, but develops slowly proximally to involve the feet and legs in a stocking distribution [3].

Its clinical manifestations include painful neuropathic symptoms and insensitivity, which increases the risk for burns, injuries and foot ulceration. Diabetic peripheral neuropathy is the most common neuropathic syndrome seen in persons with diabetes. DPN is 'symmetrical, length-dependent sensorimotor polyneuropathy attributable to metabolic and micro-vessel alterations as a result of chronic hyperglycaemia exposure. Symptomatic muscle weakness tends to develop later in the disease course [4,5].

DM-related muscle atrophy and weakness may be partly due to loss of motor unit or motor axon.

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Estimates of electro-physiologically derived number of motor units (MUNEs) in human patients with DPN were shown to significantly reduce one lower limb distal muscle, specifically an intrinsic foot muscle, an Extensor Digitorum Brevis (EDB) and, in preliminary report, in the Tibialis Anterior (TA) [6].

Kinesio Tape (KT) use has become increasingly popular in recent years. KT has been designed to mimic human skin qualities. It is about the same thickness as the epidermis [7]. Before applying to the skin, Kinesio tape can be stretched up to 140% of its original length. It has been shown to support muscle movement, relieve pain, correct misalignments of the muscle fascia and joints. Research suggested that Kinesio tape normalizes muscle function [8].

Kinesio tape enables dynamic stabilization as it provides sensorimotor stimulation, which can increase muscle recruitment depending on the direction of application and tension of the tape and by increasing proprioception [9]. Research by Mori et al., suggested that KT normalizes muscle function. The stimuli are easier to administer to the brain's motor areas by using KT on the skin (somatic sensation-induced brain wave) [10].

The Kinesio Taping can increase muscle strength, and the theories of many investigators to understand the potential underlying mechanism, including neural facilitation and mechanical restraint Macgregor et al., established the relationship between cutaneous afferent stimulation and motor unit firing [11]. Depending on the direction of application and tape tension increasing proprioception and increasing or inhibiting muscle recruitment can be obtained. Positive results of the KinesioTM tape and its effect on muscle which centers more on increasing neuromuscular recruitment [9].

Previous studies have shown that resistance exercises elicits improvement in muscle strength by hormonal and neuronal changes that occurs in response to resistive exercises, resistance training improves muscle strength by improving muscle mass and protein synthesis. This occur Via controlling the concentrations of several hormones known to affect muscle protein synthesis as testosterone, human growth hormone, and cortisol are acutely modulated in response to resistance exercise. Such anabolic hormones help muscle to build up protein and increase force production [13].

This study was done to investigate the effect of KinesioTM tape and resistive exercise on dorsiflexors functional performance in diabetic patients

with peripheral neuropathy and compare between them.

Subjects, Material and Methods

Subjects' characteristics and general experimental design:

Study subjects:

Forty Type II diabetic patients- controlled-diagnosed by physician and confirmed by laboratory investigations (HbA1c, FBG) with mild DPNs were selected from Physical Therapy Department in Diabetes Institute Cairo University the study began September 2018 till March 2019. The patients were diagnosed and examined to confirm absence of other neuro muscular problems, lower limb fractures or trauma or any significant renal hepatic and cardiovascular problem that may interrupt patients' functional performance. Their ages ranged from 50-60 years old.

Evaluated parameters:

I- Muscle strength:

Lafayette muscle tester (model #01163) was used to assess the muscle strength of the Dorsiflexors before and after the treatment. The Lafayette Manual Muscle Test System features a lightweight (10.6 oz) microprocessor-control unit that measures peak force (pounds or kilograms), time to reach peak force, and total test time, while storing up to 52 tests. Test times can range from 1-10s, and an audible tone indicates the end of the preset time. The unit provides a built-in calibration routine that verifies a valid calibration. The software menus allow browsing of device options. It has an accuracy of ± 1 percent, and the battery life is 85h [14].

II- Functional performance:

The 6 MWT is a useful measure of functional capacity. It has been widely used for measuring the response to therapeutic interventions. It reflects the capacity to undertake day-to-day activities. Some measures should be taken in account in 6 minutes' walk test according to as the patient wore comfortable footwear, during the test the therapist did not walk with the patient or even behind him as it would alter their pace. If the patient was using supplemental oxygen during the walk, the therapist did not him help to push the oxygen tank. The phrases of instructions were standardized when delivered to all the patients. Treadmill was not used. The track was not oval or circular but straight while the beginning and the end of the test corridor or space was marked with cones. The six minutes was set with a stopwatch and the total distance made by the patient was measured and recorded [15].

Treatment protocols:

Patients were assigned to two groups equal in number. (Group A) patients in this group (n=20) received traditional physical therapy in the form of resistive exercise program for eight weeks, three times per week. While Group (B) used KinesioTM tape as a therapeutic method that was applied to dorsiflexors 24 hours a day and was replaced every 5 days for eight weeks. The sessions were supervised and participation assessed. All subjects were free to withdraw from the study at any time. All participants provided their informed consent after receiving a detailed explanation of the study. The Ethics Committee of Research in Faculty of Physical Therapy, Cairo University approved the study. The data of all the participants were available for analysis. The detailed protocol was as follows:

- *Group A:* Resistive exercise was done according to patient's muscle strength. Patient were seated in sitting position and the weight sandbags were being applied at the dorsum of the foot. The resistance was set to be around 40%-60% of the 1RM. The patient did the exercise for 3 bouts, every bout was 10 repetitions, 3 training sessions were three times per week for 8 weeks. The one repetition maximum (1RM) was established prior to the training period using the following equation:

$$1 \text{ RM} = \text{Weight (kg)} \times (1 + \{0.033 \times \text{number of repetitions}\}) \text{ [16].}$$

- *Group B:* Patients were taped as in accordance to Kenzo Kase's Kinesio taping Manual. For taping, each patient's leg was placed in a relaxed position while he sits on a taping table. The skin should be free of oils and lotions; to avoid anything that may limits the acrylic adhesive's ability to adhere to the skin. So, the subject's skin was cleaned with alcohol prior to tape application; Tibialis anterior; I tape was measured from the muscle origin to the insertion while the muscle is stretched. The base of the tape was applied to the origin at the lateral condyle and superior 2/3 of anterolateral surface of tibia. Then the subject was asked to stretch the foot into planter flexion and eversion; taping was then finished toward the insertion at the medial and plantar surface of medial cuneiform; base of the first metatarsal. Extensor Digitorum Longus; a 'Y' band was used lateral to the tibialis anterior origin as the muscle extends from lateral condyle of tibia and superior three quarters of medial surface of fibula and interosseous membrane then the subject was asked to plantarflex the feet and lateral 4 toes then the tape was extended to the muscle insertion at middle and distal phalanges of lateral four

digits. Extensor hallucis longus; 'I' band was applied while big toe and the Ankle is plantar flexed from the muscle's origin at middle part of anterior surface of fibula to the Dorsal aspect of base of distal phalanx of great toe.

Statistical analysis:

The mean values of muscle strength of Dorsiflexors (both right and left) and six minutes walking test were obtained. The results before and after treatment in each group were compared using the paired "t" test. An independent "t" test was used for the comparison between the two groups ($p < 0.05$).

Results

By comparing the pre and post-intervention values of (Group A) or the exercise group using paired t-test:

- The mean value of muscle strength of the right side improved with the mean difference (39.2 ± 63.2) which was a significant difference ($p < 0.05$).
- The mean value of muscle strength of the left side improved with the mean difference (14.7 ± 68.8) which was not a significant difference ($p > 0.05$).
- And the mean value of functional performance improved the mean difference (30.7 ± 31.8) which was a significant difference ($p < 0.05$).

Table (1): Comparison between pre and post resistive exercise measures.

Items	Pre-exercise Mean \pm SD	Post-exercise Mean \pm SD	Mean difference Mean \pm SD	Paired t-test & p-value
• Rt. muscle strength	295.4 \pm 84.7	334.5 \pm 104.0	39.2 \pm 63.2	t-test=2.7 p=0.012*
• Lt. muscle strength	296.2 \pm 115.2	310.8 \pm 111.1	14.7 \pm 68.8	t-test=0.9 p=0.35
• Six-minutes walking test	345.6 \pm 62.8	376.4 \pm 70.9	30.7 \pm 31.8	t-test=4.3 p<0.001*

*: Significant p-value ($p < 0.05$).

By comparing the pre and post-intervention values of (Group B) or the KinesioTM tape group using paired t-test:

The mean value of muscle strength of the right side improved with the mean difference (89.4 ± 78.0) which was a significant difference. ($p < 0.05$).

The mean value of muscle strength of the left side improved with the mean difference (89.4 ± 78.0) which was a significant difference. ($p < 0.05$).

- And the mean value of functional performance improved with the mean difference (44.3 ± 38.8) which was a significant difference. ($p < 0.05$).

Table (2): Comparison between pre and post KinesioTM tape application measures.

Items	Pre-Kinesio tape Mean \pm SD	Post-Kinesio tape Mean \pm SD	Mean difference Mean \pm SD	Paired <i>t</i> -test & <i>p</i> -value
• Rt. muscle strength	296.1 \pm 66.8	385.5 \pm 102.5	89.4 \pm 78.0	<i>t</i> -test=5.1 $p < 0.001^*$
• Lt. muscle strength	293.5 \pm 72.8	364.6 \pm 98.2	71.1 \pm 82.1	<i>t</i> -test=3.8 $p = 0.001^*$
• Six-minutes walking test	344.1 \pm 73.2	388.4 \pm 84.7	44.3 \pm 38.8	<i>t</i> -test=5.1 $p < 0.001^*$

*: Significant *p*-value ($p < 0.05$).

Comparison of pre-intervention measures between Kinesio tape group and exercise group:

By comparing the pre-intervention values of both groups. There were no significant difference ($p > 0.05$) between the two groups at the beginning of the study.

Table (3): Comparison of pre-intervention measures between KinesioTM tape group and exercise group.

Measures	Group name	Exercise group No.=20 Mean \pm SD	Kinesio tape group No.=20 Mean \pm SD	Sig. Test* <i>p</i> -value
Pre-Rt. muscle strength		295.4 \pm 84.7	296.1 \pm 66.8	$p = 0.97$
Pre-Lt. muscle strength		296.2 \pm 115.2	293.5 \pm 72.8	$p = 0.93$
Pre-six min test		345.6 \pm 62.8	344.1 \pm 73.2	$p = 0.941$

SD: Standard Deviation. *p*-value is significant at < 0.05 .

* : Paired *t*-test.

There was no significant difference between the KinesioTM tape group and exercise group regarding the pre-intervention measures ($p > 0.05$).

Comparison of post-intervention measures between Kinesio tape group and exercise group:

By comparing the post-intervention values of both groups the KinesioTM tape and the exercise group. There was no significant difference ($p > 0.05$) between the two groups (Table 4).

Table (4): Comparison of post-intervention measures between Kinesio tape group and exercise group.

Measures	Group name	Exercise group No.=20 Mean \pm SD	Kinesio tape group No.=20 Mean \pm SD	Sig. Test <i>p</i> -value
Post Rt. muscle strength		334.5 \pm 104.0	385.5 \pm 102.5	$p = 0.12$
Post Lt. muscle strength		310.8 \pm 111.1	364.6 \pm 98.2	$p = 0.11$
Post six min test		376.4 \pm 70.9	388.3 \pm 84.7	$p = 0.63$

SD: Standard Deviation. *p*-value is significant at < 0.05 .

* : Paired *t*-test.

So, it was concluded that the KinesioTM tape was found to improve the results better than the resistive exercise but without significant difference ($p > 0.05$) between the Kinesio tape group and exercise group regarding the post-intervention measures.

Discussion

This study was done to investigate the effect of Kinesio tape and resistive exercise on dorsiflexors functional performance in diabetic patients with peripheral neuropathy and compare between them.

Forty diabetic patients-Type II-with diabetic Polyneuropathy (diagnosed by Physician and confirmed by Laboratory investigations) were selected from Physical Therapy Department in Diabetes Institute Cairo University.

The patients were diagnosed and examined to confirm absence of other Neuro Muscular problems, lower limb fractures or trauma or any significant renal hepatic and cardiovascular problem that may interrupt patients' functional performance.

Their ages ranged from 50-60 years old they were assigned to two Groups equal in number:

Group (A) received traditional physical therapy in the form of resistive exercise program for eight weeks, three times per week.

The exercise was done in three Bouts, every Bout contains 10 repetitions and the resistance was set to 40-60% of the one repetition maximum (1RM).

While Group (B) used KinesioTM tape as a therapeutic method that was applied to dorsiflexors 24 hours a day and was replaced every 5 days for eight weeks.

The results of the study were concluded that both resistive exercises and KinesioTM tape have significant effect in improving muscle strength and functional performance and although KinesioTM tape showed better improvement, statistically there was no significant difference between both of them.

This study agreed with the study done by Bischoff and his colleagues as they concluded that the use of Kinesio Taping has a positive effect on proprioception in patients with an anterior cruciate ligament rupture. Therefore, the application may improve gait pattern and functional performance of the affected knee joint [17].

This study also agreed with Vithoulka and his colleagues who confirmed that Kinesio™ tape has a significant effect on the eccentric muscle strength in healthy adults when applied on ankle muscles [18].

This study also agreed Mostert-Wentzel and his colleagues with who founded that Kinesio™ tape improved explosive power of gluteus maximus among male athletes and confirmed the positive outcome in muscle power after the use of Kinesio™ tape [19].

This study also agreed with Jung-Hong and colleagues who found that the application of Kinesio™ tape to the flexor muscles of the dominant hand significantly increased grip strength among healthy adults [20].

This study came in contrast to a study concluded by Halseth and his colleagues who reported that the application of Kinesio™ tape does not appear to enhance muscle power proprioception or functional performance (in terms of RJPS) in healthy individuals as determined by measures of RJPS at the ankle in the motions of plantar flexion and 20° of plantar flexion with inversion [21].

This study also disagreed with the study done by Chang H-Y and his colleagues who reported that Kinesio taping did not result in changes in maximal grip strength in healthy subjects [12].

Conclusion:

Within the limitations and from the obtained data of the present study the most Notable conclusion was that both resistive exercises and Kinesio™ tape improved Dorsiflexors muscles strength and patients' functional performance in diabetic Polyneuropathy. And although the Kinesio™ tape showed better results there was statistically no significant difference between the effect Kinesio™ tape and the resistive exercises on Dorsiflexors muscles strength and patients' functional performance in diabetic polyneuropathy.

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تأثير شريط كينييسيو مقابل تمارينات المقاومة على الأداء الوظيفي لعضلات شد الكاحل للأمام في إعتلال الأعصاب الطرفية بداء السكري

الخلفية: إعتلال العصبى المتعدد هى مجموعة أمراض غير متجانسة يسببها الخلل الوظيفى العصبى لمرضى السكرى. ينتج عن إعتلال الأعصاب المتعدد السكرى تغيرات مرضية مختلفة على المستوى الحسى، والحركى، والوظيفى لمرضى السكرى. ويعتقد أن طرق العلاج الطبيعى المختلفة تساعد فى التقليل من تلك التغيرات المرضية.

الهدف: الغرض من هذه الدراسة هو التحقق من تأثير شريط كينييسيو مقابل تمارينات المقاومة على الأداء الوظيفى لعضلات شد الكاحل للأمام فى إعتلال الاعصاب الطرفية بداء السكرى.

الاشخاص والإجراءات: أربعون مريض سكرى - النوع الثانى - متحكم فيه نو الإعتلال العصبى السكرى بدرجة طفيفة تتراوح أعمارهم بين ٥٠-٦٠ عاماً شاركوا فى الدراسة. وقسموا إلى مجموعتين متساويتين فى العدد (مجموعة أ) الذين عولجوا ببرنامج تمارين المقاومة لمدة ثمانية أسابيع، ثلاث مرات إسبوعياً. وعولجت (المجموعة ب) بشريط كينييسيو كطريقة علاجية والذى وضع على عضلة شد الكاحل للأمام ٢٤ ساعة فى اليوم ويستبدل كل ٥ أيام لمدة ٨ أسابيع. وإستخدم الديناموميتر المحمول باليد (فاحص العضلة اليدوى لا فاييت) لتقييم قوة العضلة، موديل #01163، بينما أجرى تقييم الأداء الوظيفى بإختبار المشى لست دقائق.

النتائج: أظهرت متوسط قيم قوة العضلة وأدائها الوظيفى قبل وبعد المعالجة إختلاف بارز للأفضل فى كلا المجموعتين لكن بدون إختلاف بارز بينهما إحصائياً فيما له علاقة بنتائج ما بعد المعالجة.

الإستنتاج: يحسن كلاً من شريط كينييزيو اللاصق وتمرارين المقاومة وبدون إختلاف إحصائى بارز فيما بينهما قوة عضلات شد الكاحل للأمام والأداء الوظيفى للمرضى فى إعتلال الأعصاب الطرفية بداء السكرى.