The Use of Kinesio® Tape for the Treatment of Foot Drop in a Patient with Sub-Acute Stroke: A Case Report

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This case report is submitted in partial fulfillment of the requirements for the degree of Doctorate of Physical Therapy.

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The Use of Kinesio® Tape for the Treatment of Foot Drop in a Patient with Sub-Acute Stroke: A Case Report

Abstract

Gait deficits are among the leading impairments in persons with stroke. The purpose of this case report is to describe and demonstrate the use of Kinesio® tape as an intervention for the treatment of foot drop in a patient with sub-acute stroke. The case patient presented with right hemiparesis and impaired functional ambulation, specifically limited by a right foot drop. The patient’s intervention consisted of four weeks of conventional physical therapy, focusing on lower extremity strengthening, balance training, and gait training, combined with the application of Kinesio® tape over the right ankle using the spring-assist technique. The results of the case report revealed improvements in both functional gait measures and in ankle dorsiflexor strength, specifically increasing from 1/5 to 2-/5 strength. Improvements in functional mobility were observed with a decrease in the Timed-Up-and-Go (TUG) score by 10.5 seconds as well as a 2-point increase in the Dynamic Gait Index (DGI). The results of the case report support the use of Kinesio® tape as an adjunct intervention for the treatment of foot drop in sub-acute stroke patients with hemiparesis. Further research should investigate the amount of influence the Kinesio® tape had towards progress as compared to the conventional physical therapy intervention.
The Use of Kinesio® Tape for the Treatment of Foot Drop in a Sub-Acute Stroke Patient: A Case Report

Introduction

In the adult population, stroke is the leading cause of long-term disability (Kesar, et al., 2010). Many individuals post-stroke exhibit motor and sensory deficits. Of these patients with stroke, 78% recover their ability to ambulate but exhibit deficits including increased energy expenditure, atypical muscle activation, and an increased incidence of falls (Embrey, Holtz, Alon, Brandsma, & McCoy, 2010). Foot drop, affecting 20% of patients with stroke, is characterized by total or partial paralysis of the ankle dorsiflexor muscles (Kesar, et al., 2010). With the high incidence of gait deficits, gait restoration is a main focus in post-stroke physical rehabilitation (Lindquist et al., 2007).

Currently, a variety of interventions are utilized in the physical therapy setting for the treatment of foot drop. The most common treatment for foot drop has been the use of an ankle-foot orthosis (AFO). An AFO is a device placed on the paretic leg which passively holds the foot at about 90° from the shaft of the tibia which allows for foot clearance during the swing phase of gait. Studies investigating the use of an AFO for the treatment of foot drop have reported a decrease in energy expenditure during ambulation, improved postural sway, increased standing symmetry, and an improved gait pattern, specifically improvements in step length and walking speed (Bulley, Shiels, Wilkie, & Salisbury, 2011). The drawbacks of using an AFO are the restriction of passive range of motion of the ankle resulting in stiffness or contractures, the limited ability to ambulate over uneven surfaces, and the discomfort of wearing the orthosis (Sabut, Sikdar, Mondal, Kumar, & Mahadevappa, 2010).
Functional electrical stimulation (FES) is another intervention for the treatment of foot drop post-stroke. FES uses electrical stimulation to activate the ankle dorsiflexor muscles and produce a muscle contraction during the swing phase of gait. A common FES unit found in the literature is the WalkAide. This stimulator is a lightweight cuff, with a molded, hard plastic insert which promotes proper positioning of the electrodes. The most common placement of the active electrode is over the common peroneal nerve, just distal and dorsal to the head of the fibula. This electrode placement allows for a combination of ankle movements, specifically ankle dorsiflexion and eversion (Stein et. al, 2010).

The WalkAide, and other stimulators, requires an initial setup process in which the therapist assesses appropriate electrode placement, synchronizes the electrical stimulation with the swing phase of the gait cycle, and calibrates the intensity of the stimulation. The electrical stimulation is synchronized with the swing phase of the gait cycle using either a tilt sensor or a heel sensor (Stein, et. al, 2010). The benefits of FES for the treatment of foot drop include stimulation of an active muscle contraction which promotes increased muscle strength, prevention of disuse atrophy, reduction of muscle tone and spasms, decreased energy expenditure of ambulation, and promotion of task-specific motor relearning (Everaert, Thompson, Chong, & Stein, 2010). The reported drawbacks to FES include the inexact timing of the electrical stimulation during the gait cycle, imprecise control of the force of the stimulation, and rapid muscle fatigue (Kesar, et al., 2010). Other drawbacks to an electrical stimulator unit include the high cost, which may not be covered under insurance, inexact placement of electrodes, intermittent
replacement of electrodes, and requirement of an initial set-up and re-calibration throughout the usage of the unit (Bulley, Shiels, Wilkie, & Salisbury, 2011).

Although drawbacks are noted with the use of FES as a treatment for foot drop, FES is an accepted and commonly utilized intervention despite the drawbacks. Individuals with foot drop who trialed a FES unit reported an improved ability to move the ankle, greater comfort, and the ability to walk more normally, safely, and independently (Bulley, Shiels, Wilkie, & Salisbury, 2011). Other benefits to using FES as an intervention for the treatment of foot drop include decreased energy expenditure of ambulation, decreased frequency of compensatory movements, decreased incidence of falls, the ability to change walking speed and cadence, and the ability to adapt to different surfaces, including grass surfaces and stair climbing (Sabut, Lenka, Kumar, & Mahadevappa, 2010).

To address the drawbacks of current foot drop interventions, additional interventions should be utilized in the clinic as well as addressed in the literature. No research articles were found in a search of the literature concerning Kinesio® tape as a treatment for foot drop. The purpose of this case report is to describe and demonstrate the use of Kinesio® Tape as an intervention for the treatment of foot drop in a sub-acute stroke patient with hemiparesis.

**Background on the use of Kinesio® tape**

Kinesio® taping is a relatively new technique being used during physical therapy treatments. Kinesio® tape is a thin, highly elastic material which stretches 120-140 % times its original length (Fu et al., 2007). The tape can be worn continually for 3-5 days
and is able to get wet. Kinesio® tape allows for dynamic stabilization without restricting blood or lymph flow. The highly elastic material is theorized to lift the skin and superficial tissues to promote circulation and provide sensorimotor stimulation. These unique characteristics make Kinesio® tape versatile in its therapeutic effects. Depending on the direction of application and tape tension, the clinical uses of Kinesio® tape include: relieving pain, correcting joint positioning, decreasing swelling, increasing proprioception, and increasing or inhibiting muscle recruitment (Cepeda, Fishweicher, Gleeson, Greenwood, & Motyka-Miller, 2008). Increasing proprioception and muscle recruitment may help decrease foot drop in people post-stroke.

Research on the use of Kinesio® tape to increase muscle strength is limited and inconsistent. No articles were found in the literature concerning the lower extremity and Kinesio® tape as a treatment in patients with stroke. One case report was identified in the literature which documented the use of Kinesio® tape as an intervention for shoulder subluxation in a patient post stroke. The case report concluded that in combination with a conventional rehabilitation program, the Kinesio® tape may contribute to the reduction of shoulder pain, improved glenohumeral joint alignment, and increased neuromuscular recruitment of the rotator cuff muscles (Jaraczewska & Long, 2006).

The use of Kinesio® tape on five children with hypotonia was reported to have a therapeutic effect with application of tape over of the abdominal muscles, specifically facilitating recruitment of the internal and external oblique muscles bilaterally. All five children demonstrated improved abdominal muscle tone as well as decreased amount of compensatory movements during supine-to-sit transfers (Cepeda & Fishweicher, 2008).
Two unassociated research studies quantified the amount of increase in strength of both the quadriceps femoris and hamstrings concentrically and eccentrically in healthy adults using an isokinetic dynamometer. One study concluded no increase in muscle strength immediately after, and 12 hours after, Kinesio® tape application to the rectus femoris, as compared to baseline and placebo tape measures (Fu, Wong, Pei, Wu, Chou, & Lin, 2008). Conversely, a similar research study reported a statistically significant increase in eccentric quadriceps femoris strength as compared to baseline and placebo-tape measures, with the application of Kinesio® tape to the rectus femoris, vastus lateralis, and vastus medialis. No increase in hamstring strength or quadriceps femoris concentric strength were observed in the study.

Studies that examine the therapeutic application of Kinesio® tape to a population with prior muscular weakness report more consistently positive results. This trend supports that Kinesio® tape provides a more subtle muscular effect which centers more on increasing neuromuscular recruitment rather than increasing healthy muscle strength.

**Case Description**

The patient was a 56 year old male who presented with right-sided hemiparesis due to a cerebral vascular accident (CVA). Magnetic resonance imaging (MRI) confirmed the diagnosis of an ischemic CVA near the left brainstem. The case patient received a total of 3 weeks of physical and occupational therapy in acute-care and inpatient rehabilitation before being referred to an outpatient rehabilitation facility.
Social History/Past Medical History

Prior to the CVA, the patient led an active, independent lifestyle which included working full-time as a licensed realtor as well as playing tennis two times per week. He had a 24 year history of smoking a pack of cigarettes per day. The patient lived with his wife in a first-floor condo with one 4-inch step to enter the home. His past medical history included high blood pressure which was managed medically with lisinopril (Zestril) 20mg once a day.

Examination

During the initial examination, the patient independently answered all subjective questions and was alert and oriented to person, place, time, and event. Vitals were within normal limits, specifically blood pressure 122/84 mmHg, heart rate 73 bpm, and 98% oxygen saturation. Upon physical observation, the patient displayed right upper and lower extremity hypotonicity. Standing posture assessment revealed increased weight-shift toward the left, as well as decreased terminal knee extension and increased hip flexion on the right side. During ambulation with a hemi-walker, the patient displayed a decreased cadence, decreased left lower extremity step length, wide base of support, and decreased stance time on the right lower extremity secondary to decreased weight-shift. During the right lower extremity stance phase, a positive Trendelenburg sign was observed as well as decreased terminal knee extension as a result of decreased gluteus medius and quadriceps femoris strength respectively. During right lower extremity swing phase, a positive foot drop was observed as well as a decreased heel strike at initial contact as a result of decreased ankle dorsiflexor strength.
At initial examination, the patient was independent with all bed mobility demonstrating compensatory strategies for right upper and lower extremity management. With a hemi-walker and supervision for safety, the patient was able to transfer to the left by performing a sit-to-stand transfer followed by taking small, alternating steps to turn in place until in position to safely sit down. Minimal assistance was required for steadying and appropriate weight-shifting with attempts to transfer toward the involved side. For house-hold distances, the patient was able to ambulate with a hemi-walker and supervision for safety. The longest distance ambulated in inpatient rehabilitation was documented at 50 feet. The patient required moderate assistance for steadying, weight shifting, and right lower extremity placement with mobility up and down a 4-inch step with a hemi-walker.

Sensation, specifically light, sharp, and dull touch, was assessed by means of a light-touch brush and sharp-dull tool respectively. Sensation was intact and localized bilaterally. Proprioception was assessed bilaterally at the big toe. The patient correctly identified the direction of movement of the big toe in 5 of 5 trials bilaterally. Deep tendon reflexes (DTRs) were assessed at the patellar and Achilles tendon. The left lower extremity presented with normal DTRs (2+). The right patellar reflex which was slightly hyper-reflexive (3+) and the right Achilles reflex which was hyper-reflexive with an unsustained clonus of 3 beats (4+). Upon manual stretch, a 3 beat clonus was elicited in the right ankle.

Muscle length testing of the lower extremity was performed to assess the length of the hamstrings and gastrocnemius muscles. Hamstring length was examined with a goniometer via the passive 90-90 hamstring test. The left and right hamstring length were
within functional limits (WFLs), with a difference of 5° comparatively. Gastrocnemius muscle length was examined with a goniometer measuring passive dorsiflexion at the ankle during full knee extension. Muscle shortening was observed at the right ankle, measuring 5° of passive dorsiflexion as compared to 15° passive dorsiflexion of the left ankle. Left lower extremity range of motion (ROM) was WFLs for both active and passive ranges. Right lower extremity passive ROM was WFLs, except for ankle dorsiflexion as previously stated. Active ROM of the right lower extremity was limited secondary to decreased strength to move the joint through the full range.

Left lower extremity strength was assessed by means of manual muscle testing and revealed normal strength (5/5). Table 1 contains the specific muscle groups tested and results. The right lower extremity presented with less than antigravity strength (< 3/5) for all muscle groups except the hip adductors (4-/5) and knee extensors (3+/5). Right ankle dorsiflexor strength, was graded as 1/5 strength or a trace palpable muscle contraction.

Table 1: Manual Muscle Testing Initial Values

<table>
<thead>
<tr>
<th>Muscle Group</th>
<th>Right Lower Extremity</th>
<th>Left Lower Extremity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Flexors</td>
<td>2/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Hip Abductors</td>
<td>2/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Hip Adductors</td>
<td>4-/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Knee Extensors</td>
<td>3+/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Knee Flexors</td>
<td>2/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Ankle Dorsiflexors</td>
<td>1/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Ankle Plantarflexors</td>
<td>2-5/5</td>
<td>5/5</td>
</tr>
</tbody>
</table>
Outcome Measures

To assess the efficacy of the intervention, outcome measures were utilized to specifically evaluate ankle dorsiflexor strength and functional ambulation. The outcome measures included manual muscle testing of the ankle dorsiflexor muscles, the Timed Up and Go (TUG) test, and the Dynamic Gait Index (DGI).

Manual muscle testing is a commonly used examination tool used to assess the strength of a particular group of muscles. The strength of the group of muscles is graded based on multiple factors: gravity, the range of movement, and the amount of force resisted by the muscle(s) (Florence et al., 1992). The strength of each muscle group was assessed using was the modified Medical Research Council (mMRC) grading scale. The mMRC scale demonstrates a high intrarater reliability ($r = 0.81$) for the ankle dorsiflexor muscles (Florence et al., 1992). The grading scale uses numbers, ranging from 0 to 5, to grade muscle group strength, with 0 being no movement and 5 being normal strength. The modification of the mMRC scale incorporates the use of “+” and “-” to the numerical score to include additional grading subdivisions. Table 2 lists the mMRC grading criteria for each numerical value. The patient was unable to dorsiflex the ankle through any range of motion in the gravity-eliminated position. A contraction of the tibialis anterior was palpable during manual muscle testing, grading ankle dorsiflexion 1/5 strength.
Table 2: Description of mMRC Scale Values

<table>
<thead>
<tr>
<th>Numerical Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No movement</td>
</tr>
<tr>
<td>1</td>
<td>A flicker of movement is seen or palpated in the muscle.</td>
</tr>
<tr>
<td>2-</td>
<td>Muscle moves the joint through partial range of motion when gravity is eliminated.</td>
</tr>
<tr>
<td>2</td>
<td>Muscle moves the joint through full range of motion when gravity is eliminated.</td>
</tr>
<tr>
<td>2+</td>
<td>Same as grade 2, but muscle holds the joint against minimal resistance.</td>
</tr>
<tr>
<td>3-</td>
<td>Muscle moves the joint against gravity, but not through full mechanical range of motion.</td>
</tr>
<tr>
<td>3</td>
<td>Muscle cannot hold the joint against resistance, but moves the joint through full the range of motion against gravity</td>
</tr>
<tr>
<td>3+</td>
<td>Muscle moves the joint fully against gravity and is capable of transient resistance, but collapses abruptly.</td>
</tr>
<tr>
<td>4-</td>
<td>Same as grade 4, but muscle holds the joint only against minimal resistance.</td>
</tr>
<tr>
<td>4</td>
<td>Muscle holds the joint against a combination of gravity and moderate resistance.</td>
</tr>
<tr>
<td>4+</td>
<td>Same as grade 4, but muscle holds the joint against moderate to maximal resistance.</td>
</tr>
<tr>
<td>5</td>
<td>Normal strength; muscle holds the joint against gravity and maximal resistance.</td>
</tr>
</tbody>
</table>

(Florence et al., 1992)

The DGI requires the patient to perform eight functional ambulation activities which mimic activities of daily living such as stair climbing, walking while turning the head, and stepping over or around objects. The DGI was used to specifically assess the functional stability of the patient during ambulation activities as well as evaluate the risk of falling. The DGI rates the performance of each activity on a 0 (poor) to 3 (excellent) scale, ranging the total score of the DGI from 0 to 24. Appendix A includes a DGI scoring sheet (University of Missouri, 2013). For persons with stroke, research supports the use of the DGI as a highly reliable and valid assessment of balance and mobility.
In persons with chronic stroke, high test-retest and interrater reliability were recorded ($r = 0.96$) using the DGI. Construct validity are ranked good to acceptable, with intraclass correlation coefficients ranging from 0.68-0.83, when compared to other dynamic balance assessments (Jonsdottir & Cattaneo, 2007). The patient’s initial DGI score totaled 12/24 points. The individual DGI task scores pre-intervention and post-intervention are provided in Table 3.

The TUG is a functional mobility test which requires the patient to stand up from a standard height chair (18 inches), walk 3 meters, turn around, walk back, and sit down in the chair. Figure 2 illustrates the TUG set-up. The time to complete the TUG is recorded. A variety of mobility activities are required to be performed in the TUG including sit-to-stand and stand-to-sit transfers, ambulation, and turning around 180\(^\circ\). The TUG instructions and scoring sheet are provided in Appendix B. Among persons with stroke, the TUG exhibits a high test-retest reliability ($r = 0.95$) as a measure of functional ambulation, specifically demonstrating significant correlations with gait speed, gait velocity, and step length of both the affected and unaffected limb (Ng & Hui-Chan, 2005). The initial TUG times were 51 seconds in trial 1 and 49 seconds in trial 2; making the average time-to-complete 50 seconds. TUG scores, pre-intervention and post-intervention, are provided in Table 3.
Intervention

The plan of care consisted of 45 minute treatments, three times a week for four weeks, specifically Monday, Wednesday, and Thursday. Occupational therapy was also provided three times a week to address the right upper extremity neuromuscular impairments. Conventional physical therapy intervention focused on gait restoration, as well as neuromuscular re-education and strengthening of the right lower extremity. The majority of neuromuscular re-education and strengthening exercises were closed chain exercises performed in supine or standing. Facilitation was provided to the right lower extremity by approximation of the distal joints, quick stretch of the muscle, or tactile facilitation over the muscle belly. Gait training interventions followed the principles of motor re-learning in which multiple repetitions of task-specific activities result in changes in the nervous system which carry over as improvements in motor behavior (Lindquist et al., 2007). Gait training initially focused on improving the quality of gait, with short distance ambulation of less than 25 feet. Manual cues included preventing the right knee from buckling during the loading to mid-stance phase of gait as well as facilitation of the hip flexors via quick stretch for right lower extremity advancement during pre-swing. The intervention gradually progressed by means of increasing the distance ambulated as well as incorporating DGI activities into gait training.

The Kinesio® tape was applied using a spring-assist technique, also referred to as a functional correction. The spring-assist technique utilizes both mechanical and sensorimotor stimuli to facilitate the ankle dorsiflexor muscles. The application of the tape began with the patient’s right ankle passively positioned into full dorsiflexion. The length of the Kinesio® tape used was measured from the anterior surface of the mid-tibial
shaft to the base of the metatarsals on the dorsal surface of the foot. The tape was then anchored on the anterior surface of the mid-tibial shaft, with approximately two inches of tape with no tension. With the ankle still in full dorsiflexion, the tape was applied with 50-75% tension to the base of the metatarsals in the center of the dorsal surface of the foot. Another two inch anchor with no tension was applied distally over the metatarsals. The ankle was passively positioned into full plantarflexion where the tape was applied to the skin in a proximal to distal direction. The tape was rubbed to activate the adhesive backing and assure the tape was applied flush to the skin (Kinesio® Taping Association International, 2011). Due to increased leg hair, the patient was required to shave the taping site to maximize contact of the tape with the skin. Figure 1 illustrates the Kinesio® tape application technique.

The direction of pull of the Kinesio® tape combined with the high tension of the tape elicits both the mechanical and sensorimotor response. The proximal to distal taping sequence creates a rebound tension force in the proximal direction assisting to lift the foot and promote dorsiflexion. The tension of the Kinesio® tape also elicits a reaction in the proprioception of the ankle joint thus stimulating a sensorimotor reaction in the targeted tissue. The tension perceived by the proprioceptors in the ankle joint is theorized to create a sensorimotor response which increases the neuromuscular recruitment of the ankle dorsiflexor muscles. Due to the taping technique, the more the ankle falls into plantarflexion, the greater the tension in the tape, thus a greater stimuli to the targeted tissue (Kinesio® Taping Association International, 2011).

The only exercise performed that specifically addressed the ankle dorsiflexor muscles included supine active-assisted ankle dorsiflexion and plantar flexion. Each
treatment day during the four week intervention, the patient performed two sets of ten repetitions, alternating active-assisted dorsiflexion and plantarflexion of the right ankle. The patient wore the Kinesio® tape continually, both at home and during therapy, which allowed for continual sensorimotor facilitation. The tape was removed and reapplied by a physical therapist every Monday and Thursday before treatment began. No adverse reactions at the application site and no subjective complaints were reported during the course of the intervention.

Figure 1 Spring-Assist Technique to Right Ankle

Outcomes

After the four week intervention, the patient was reassessed per manual muscle testing, TUG, and DGI. The results are shown in Table 3. Manual muscle testing of the right ankle dorsiflexor muscles resulted in 2-/5 strength, by demonstrating partial active
range of motion in the gravity-eliminated position (Florence, 1992). The TUG scores were 42 seconds and 37 seconds, for trial 1 and trial 2 respectively, producing an average TUG score of 39.5 seconds. The DGI total score improved by 2-points, resulting in a total of 14/24 points. Specifically, the two DGI categories which improved by one point were stepping over objects and step mobility.

Table 3: Pre & Post Intervention Outcome Measures

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGI (Total)</td>
<td>12/24</td>
<td>14/24</td>
</tr>
<tr>
<td>Gait level surface</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Change in gait speed</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gait with horizontal head turns</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Gait with vertical head turns</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Gait and pivot turn</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Step over obstacle</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Step around obstacles</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Steps</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TUG (Average)</td>
<td>50sec</td>
<td>39.5sec</td>
</tr>
<tr>
<td>Trial 1</td>
<td>51sec</td>
<td>42sec</td>
</tr>
<tr>
<td>Trial 2</td>
<td>49sec</td>
<td>37sec</td>
</tr>
<tr>
<td>Manual Muscle Test</td>
<td>1/5</td>
<td>2/5</td>
</tr>
</tbody>
</table>

Discussion

The results of this case report suggest that combined with conventional therapy, the spring-assist application of Kinesio ® tape may be a suitable adjunct intervention for the treatment of foot drop in sub-acute stroke patients. The amount of increase of ankle dorsiflexor strength was minimal, being only a half grade increase from 1/5 to 2-5 strength. Even though only a slight increase in strength was observed, the strength gains made are a positive prognostic sign in terms of eventual recovery of functional strength.
(Hislop & Montgomery, 2007). According to the literature, these strength gains may be indicative of regeneration of corticospinal connections and thus eventual recovery of functional strength (Everaert, Thompson, Chong, & Stein, 2010).

Due to patient fatigue during the initial TUG measurements, the TUG test was only performed twice instead of three trials which is commonly reflected in the literature. To be comparative to the initial measures, only two TUG trials were performed in the post-intervention measurements. An improvement was observed in the time required to complete the TUG test, decreasing the average time by 10.5 seconds. In persons with stroke, the TUG has a high correlation with gait speed, velocity, and step length of both the unaffected and affected limb. The increased gait speed may be attributed to improved advancement of the affected lower extremity during the swing phase of gait. This is supported by the positive correlation between TUG times and stance time of the unaffected lower extremity; p = .740 (Ng & Hui-Chan, 2005). The increased gait speed of the case patient may also be attributed to improved step length of both the affected and unaffected lower extremities. In persons with stroke, the literature supports a negative correlation is between TUG scores and step length of both the affected and unaffected lower extremities, p = -0.67 and -0.80 respectively (Ng & Hui-Chan, 2005). Though no objective measures concerning specific gait parameters were performed in this case report, the improvements in the above mentioned gait parameters were supported by the high correlation within the literature between TUG scores and improvements in both step length and stance time (Ng & Hui-Chan, 2005). Even though improvements in the TUG score were observed, based on normative data the patient is still at high risk for falls, requiring greater than 14 seconds to complete (Shumway-Cook, Brauer, & Woolacott,
2000). Requiring greater than 30 seconds to complete the TUG is also predictive that the patient will not be independent with functional mobility and will most likely continue to require assist for safety (Shumway-Cook, Brauer, & Woolacott, 2000). In accordance with the literature, the patient’s current TUG score of 39.5 seconds supports the continued use of an assistive device, specifically a hemi-walker, as well as continued close stand by assist during ambulation due to his high fall risk.

One-point improvements in the DGI were observed in two categories: stepping over objects and step mobility. The patient progressed from not being able perform the step task, to being able to ascend and descend four steps with moderate impairment, defined as demonstrating a step-up pattern with two feet to a step and using the left hand rail (University of Missouri, 2013). The common theme within these two categories is the requirement of single limb stance stability to either step over objects or up steps. The improvement in both categories suggest an improvement in single limb stance stability of the affected lower extremity due to increased strength and neuromuscular control. Improved single limb stance stability relates to improved quality and speed of ambulation, which was also observed in the improved TUG score. According to normative data, the patient remains at a high risk for falls, scoring less than 19/24 points in total on the DGI (Cook, Baldwin, Polissar, & Gruber, 1997).

The patient was compliant with the Kinesio® tape intervention, and continually wore the tape at home and during treatment. The Kinesio® tape was only removed and reapplied twice a week by a physical therapist. The patient tolerated the continual wear of the tape well with no adverse skin reactions or subjective complaints of discomfort at the taping site. Subjectively, the patient felt that the Kinesio® tape was therapeutic and
requested to continue the intervention at the end of the study. In response to his opinion about the Kinesio® tape intervention, the patient reported, “I feel that it has helped me get my strength back in my ankle.” Overall, the results of this case report support the use of Kinesio® tape as an adjunct intervention to promote increased strength of the ankle dorsiflexor muscles and improved functional mobility in sub-acute stroke patients with foot drop.

Due to the design of the case report, there are a variety of limitations. The positive outcomes observed cannot be specifically attributed to the application of the Kinesio® tape due to the inability to compare the Kinesio® tape outcome results to the intervention providing only conventional physical therapy. Further investigation is needed to assess if the amount of progress made by the case patient was due to the conventional intervention or the influence of the Kinesio® tape. Future research should include a clinical controlled trial which compares the use of Kinesio® tape as an adjunct intervention to a control group which receives only the conventional physical therapy intervention. Future research should also examine in greater detail the influence of the Kinesio tape on the quality of gait by using gait analysis technology to objectively quantify specific gait parameters, including step length and number of pure heel strikes of the affected limb.

**Conclusion**

The results of the case report suggest that the application of Kinesio® tape, combined with conventional physical therapy intervention, is beneficial in the treatment of foot drop in sub-acute stroke patients with hemiparesis. After four weeks of treatment, the patient presented with increased strength of the right lower extremity, including the ankle.
dorsiflexor muscles, as well as improved functional ambulation as indicated by improved scores of the TUG and DGI. Further research is needed to assess the degree in which the Kinesio® tape facilitated improvements in ankle dorsiflexor strength and functional ambulation. Recommendations for future research include conducting controlled clinical trials to investigate the use of Kinesio® tape as an adjunct intervention compared to the sole intervention of conventional physical therapy to quantify the amount of influence the Kinesio® tape intervention made toward increasing the strength of the ankle dorsiflexor muscles as well as improving the quality of gait. Further research should also examine the influence of the spring-assist Kinesio taping technique on the quality of gait by obtaining objective measures on specific gait parameters, specifically step length and pure heel strikes of the affected limb.
Appendix A: Dynamic Gait Index Scoring Sheet

1. Gait level surface _____
   Instructions: Walk at your normal speed from here to the next mark (20’)
   (3) Normal: Walks 20’, no assistive devices, good sped, no evidence for imbalance, normal gait pattern
   (1) Moderate Impairment: Walks 20’, slow speed, abnormal gait pattern, evidence for imbalance.
   (0) Severe Impairment: Cannot walk 20’ without assistance, severe gait deviations or imbalance.

2. Change in gait speed _____
   Instructions: Begin walking at your normal pace (for 5’), when I tell you “go,” walk as fast as you can (for 5’). When I tell you “slow,” walk as slowly as you can (for 5’).
   (3) Normal: Able to smoothly change walking speed without loss of balance or gait deviation. Shows a significant difference in walking speeds between normal, fast and slow speeds.
   (2) Mild Impairment: Is able to change speed but demonstrates mild gait deviations, or not gait deviations but unable to achieve a significant change in velocity, or uses an assistive device.
   (1) Moderate Impairment: Makes only minor adjustments to walking speed, or accomplishes a change in speed with significant gait deviations, or changes speed but has significant gait deviations, or changes speed but loses balance but is able to recover and continue walking.
   (0) Severe Impairment: Cannot change speeds, or loses balance and has to reach for wall or be caught.

3. Gait with horizontal head turns _____
   Instructions: Begin walking at your normal pace. When I tell you to “look right,” keep walking straight, but turn your head to the right. Keep looking to the right until I tell you, “look left,” then keep walking straight and turn your head to the left. Keep your head to the left until I tell you “look straight,” then keep walking straight, but return your head to the center.
   (3) Normal: Performs head turns smoothly with no change in gait.
   (2) Mild Impairment: Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.
   (1) Moderate Impairment: Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.
   (0) Severe Impairment: Performs task with severe disruption of gait, i.e., staggers outside 15” path, loses balance, stops, reaches for wall.
4. Gait with vertical head turns
Instructions: Begin walking at your normal pace. When I tell you to “look up,” keep walking straight, but tip your head up. Keep looking up until I tell you, “look down,” then keep walking straight and tip your head down. Keep your head down until I tell you “look straight,” then keep walking straight, but return your head to the center.
(3) Normal: Performs head turns smoothly with no change in gait.
(2) Mild Impairment: Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.
(1) Moderate Impairment: Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.
(0) Severe Impairment: Performs task with severe disruption of gait, i.e., stagers outside 15” path, loses balance, stops, reaches for wall.

5. Gait and pivot turn
Instructions: Begin walking at your normal pace. When I tell you, “turn and stop,” turn as quickly as you can to face the opposite direction and stop.
(3) Normal: Pivot turns safely within 3 seconds and stops quickly with no loss of balance.
(2) Mild Impairment: Pivot turns safely in > 3 seconds and stops with no loss of balance.
(1) Moderate Impairment: Turns slowly, requires verbal cueing, requires several small steps to catch balance following turn and stop.
(0) Severe Impairment: Cannot turn safely, requires assistance to turn and stop.

6. Step over obstacle
Instructions: Begin walking at your normal speed. When you come to the shoebox, step over it, not around it, and keep walking.
(3) Normal: Is able to step over the box without changing gait speed, no evidence of imbalance.
(2) Mild Impairment: Is able to step over box, but must slow down and adjust steps to clear box safely.
(1) Moderate Impairment: Is able to step over box but must stop, then step over. May require verbal cueing.
(0) Severe Impairment: Cannot perform without assistance.

7. Step around obstacles
Instructions: Begin walking at normal speed. When you come to the first cone (about 6’ away), walk around the right side of it. When you come to the second cone (6’ past first cone), walk around it to the left.
(3) Normal: Is able to walk around cones safely without changing gait speed; no evidence of imbalance.
(2) Mild Impairment: Is able to step around both cones, but must slow down and adjust steps to clear cones.
(1) Moderate Impairment: Is able to clear cones but must significantly slow, speed to accomplish task, or requires verbal cueing.
(0) Severe Impairment: Unable to clear cones, walks into one or both cones, or requires physical assistance.

8. Steps

Instructions: Walk up these stairs as you would at home, i.e., using the railing if necessary. At the top, turn around and walk down.

(3) Normal: Alternating feet, no rail.
(2) Mild Impairment: Alternating feet, must use rail.
(1) Moderate Impairment: Two feet to a stair, must use rail.
(0) Severe Impairment: Cannot do safely.

TOTAL SCORE: ___ / 24

(University of Missouri, 2013)
Appendix B:
Timed Up-And-Go (TUG) Instructions and Scoring Sheet

Directions:
› The timed “Up and Go” test measures, in seconds, the time taken by an individual to stand up from a standard arm chair (approximate seat height of 18in), walk a distance of 3 meters, turn around, walk back to the chair, and sit down.
› The subject wears their regular footwear and uses their customary walking aid (none, cane, walker).
› No physical assistance is given.
› The individual starts with their back against the chair, their arms resting on the armrests, and their walking aid at hand. The individual is instructed that on the word “go” they are to get up and walk to a line on the floor 3 meters away, turn around, return to the chair and sit down again.
› The individual is instructed to perform the test as quickly as the individual can safely complete.
› The subject walks through the test once before being timed in order to become familiar with the test.

Instructions to the patient:
“When I say ‘go’ I want you to stand up and walk to the line, turn around, and then walk back to the chair and sit down again. Walk at your normal pace.”

Time: _ _ _ _ seconds

(University of Buffalo, 2013)
Appendix C: Independent Study Learning Activities

1. Attend Kinesio tape seminar (K1 and K2)

   For this learning activity, I attended the two-day official Kinesio® Tape Association seminar in Miami, Florida on October 6, 2012 and October 7, 2012. The seminar courses included KT1: Fundamental Concepts of Kinesio® Tape and KT2: Advanced Concepts & Corrective Techniques. These seminars are two of the three Kinesio® tape courses required to become a certified Kinesio® tape clinician. The KT1 seminar held on the first day reviewed the basic concepts of Kinesio® tape, how different tissues are affected by the tape, as well as basic application concepts. The KT2 seminar, held on the second day, reviewed the variety of different corrective techniques depending on the targeted tissue and desired therapeutic effect. Both days of the seminar provided hands-on practical application of the Kinesio® tape. The documentation of completion of this learning activity includes the KT1 and KT2 certificate of completion as well as the seminar attendance recorded, both provided by the Kinesio® Tape Association.
Kinesio® tape Certificate of Completion

Catherine Lazarus

Has successfully completed the course requirements defined by Kinesio Taping Association International, as stated below.

Kinesio Taping Association International

Kinesio® TAPE AND FOOT DROP
Kinesio® tape CEU Documentation of Attendance

Kinesio Taping Association International
CEU Documentation

Name and Title:  Catherine Lazarus
Street Address:  20260 Estero Gardens Circle Unit #204
City:  Estero  State: FL  Zip: 33928  Country: United States

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<td>Kim Rock-Eislocher, MS, CRT-L, OMILT, CT3T</td>
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KTA is a nationally approved provider for AOTA (Provider #44489).

Kinesio is recognized by the Board of Certification, Inc. to offer continuing education (CE) for Certified Athletic Trainers. This program has been approved for a maximum of 16 hours of Category A CE. Certified Athletic Trainers are responsible for claiming only those hours actually spent participating in the CE activity. BOC Approved Provider Number: PZ258. Number of hours actually participated:

KTA is a nationally approved CE provider for NCSCB (Provider #450030-05)

This course has been approved for 15 CE Hours by the Florida State Physical Therapy Association. State approval #:

DC approval if applicable; Enter DC approval if applicable

The assignment of CE Hours by these entities does not imply endorsement of specific course content, products, or clinical procedures by same. The course content is not intended for use outside the scope of the learner's license or regulation.

To be completed by Attendee if Applicable:

<table>
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<th>State</th>
<th>License Number</th>
<th>Board Approval #</th>
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Signature: [Signature]  Date: 10/7/2012
2. Complete APTA Course: *Structuring Clinical Interventions to Maximize Motor Recovery After Stroke and Spinal Cord Injury*

For this learning activity, I completed the online continuing education course (CEU) entitled *Structuring Clinical Interventions to Maximize Motor Recovery After Stroke and Spinal Cord Injury*. The course, offered through the American Physical Therapy Association (APTA), was completed online on April 21, 2013. The APTA course included both PowerPoint and lecture material which focused on interventions to maximize motor recovery in both patients post-stroke and post-spinal cord injury. This course was chosen to further my knowledge regarding interventions for patient’s post-stroke, other than Kinesio® Tape. The common theme throughout the course is the importance of high amounts of task practice, the positive correlation between the intensity and frequency of task practice with improved motor recovery, as well as stressing the importance of allowing the patient to make motor errors and learn from these errors by allowing the patient to work through and self-correct as independently as possible. To complete the course, I had to pass an exam at the end of the course material. The documentation of completion to this learning activity is the certification of completion provided by the APTA after successfully passing the course exam.
KINESIO® TAPE AND FOOT DROP

APTA Certification of Course Completion

AMERICAN PHYSICAL THERAPY ASSOCIATION
CERTIFICATE of COMPLETION

is presented to

Catherine Lazarus

For the successful completion of

Structuring clinical interventions to maximize motor recovery after stroke and spinal cord injury: the importance of amount, intensity and type of practice

0.3 Continuing Education Units, 3 Contact Hours/CCUs

April 21, 2013

Paul Rocker Jr.
PT, DPT, MS
President

American Physical Therapy Association
1111 North Fairfax Street, Alexandria, VA 22314

Participating License #: ____________
3. Intern with a physical therapist who works at NCH Stroke Rehabilitation - Day Program

For this learning activity, I performed a 6 week clinical experience at the Bonita Beach branch of a Naples Community Hospital (NCH) Outpatient physical therapy clinic. This clinic offered a Day Program every Monday, Wednesday, and Thursday which allowed patients with stroke, and other patients with neurological involvement, to come to the outpatient therapy center and receive physical, occupational, and speech therapy as needed. This learning activity provided an opportunity for cognitive, psychomotor, and affective development. At this clinic, I was able to work with a physical therapist that specialized in working with the sub-acute and chronic stroke patient population. During the Day Program, I was able to work with multiple patients with stroke as well as a few other patients with neurological involvement including: an incomplete spinal cord injury, Guillain-Barre syndrome, and a traumatic brain injury. I was able to observe interventions, obtain hands on practice treating these patients, learn different intervention techniques, and design individual plans of care for these patients. I performed this clinical rotation from June 11, 2012 thru July 27, 2012 under the supervision of Bryce Kinnas, DPT.
Cathy Lazarus attended a clinical rotation at the NCH Bonita Outpatient Rehabilitation Center, from June 11, 2012 thru July 27, 2012. During this clinical experience Cathy was able to participate in the Day Program offered on Monday, Wednesday, and Thursday which provided therapy intervention to neurologically involved patients, most frequently stroke patients. During this experience, Cathy was able to observe as well as provide treatment to a variety of neurologically involved patients under the supervision of her clinical instructor Bryce Kinnas, DPT.

Bryce Kinnas, DPT

During my clinical experience at the Bonita NCH Outpatient Clinic, I was able to conduct a case report concerning the effects of Kinesio® tape for the treatment of foot drop in a sub-acute stroke patient. The case patient presented with hemiparesis and foot drop on the right side. Being toward the end of my clinical experience, my clinical instructor allowed me to develop a plan of care as well as use the Kinesio tape as an adjunct intervention. The taping technique I used for the patient’s foot drop was a spring-assisted technique to the right ankle. The documentation of the case report is presented above, ranging from the initial evaluation, the intervention provided, and finally the outcome results.

The proof of this learning activity is the written, and approved case report “The Use of Kinesio® Tape for the Treatment of Foot Drop in a Patient with Sub-Acute Stroke: A Case Report” which is provided above.
References


University of Missouri. (2013). *Dynamic Gait Index*. Retrieved on April 21, 2013, from the University of Missouri Health Professions Database: