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# The Effects of Therapeutic Taping on Pain, Range of Motion, Power, Balance, and Strength, in Athletes and Non-athletes With and Without Acute Patellar Tendinopathy

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**Abstract**

Kinesio tape (KT) and Leukotape (LT) constitute two of the most common types of therapeutic taping techniques used in injury rehabilitation. Currently, it is unclear if, or how, the use of such tapes may affect different motor abilities such as strength, power, balance, and range of motion (ROM), across different populations. Three female athletes with acute patellar tendinopathy (M = 20.0±1.0 years) and five non-athletes without (3 males and 2 females, 22.8 ±1.3 years) participated in this proof of concept preliminary study. A Group (comparison vs. affected) x Condition (KT; LT; No tape (NT)) mixed factorial design, with repeated measures on the second factor was implemented. Five dependent variables were examined including pain, ROM, power, balance, and strength. Overall, non-parametric statistics revealed no significant differences during the assessment of pain, ROM, power, balance, and strength. Therapeutic taping has minimal effect on varsity athletes and non-athletes with and without acute patellar tendinopathy.

**Keywords:** Therapeutic tape, leukotape, kinesio tape, patellar tendinopathy

## 1.0 Introduction

Acute patellar tendinopathy is a common musculoskeletal injury found across all levels of sport and sedentary lifestyles (Kountouris& Cook, 2007; Magra&Maffulli,2008). Nearly 10% of all hospital visits and about one-third of sports injuries are related to tendinopathies (Murtaugh & Ihm, 2013). Generally, sports like volleyball and basketball have the highest prevalence for this injury (Blazina, Kerlan, Jobe, Carter, & Carlson, 1973; Garau, Rittweger, Mallarias, Longo, & Maffulli, 2008;Khan, Maffulli, Coleman, Cook, & Taunton, 1998). It is likely that the repetitive jumping results in degenerative structural changes in the tendon leading to adverse effects (Peers &Lysens, 2005; Garau et al., 2008). If unattended, this injury can negatively influence athletic performance, participation in physical activity, quality of life in general, and lead to full thickness tearing of the tendon (Murtaugh & Ihm, 2013).The literature has attempted to identify successful treatment options but it remains unclear if conservative techniques like therapeutic taping have beneficial effects on athletes suffering from acute patellar tendinopathy (Gaida & Cook, 2011).

During tasks like jumping or squatting, the patellar tendon is susceptible to large amounts of force throughout the joint's primary movements (Gaida & Cook, 2011; Hale, 2005; Kountouris & Cook, 2007). The athlete must forcefully extend the knees and plantar flex the ankles simultaneously in order to propel into the air (Chen-Yu, Tsung-Hsun, Szu-Ching, & Fong-Chin, 2011).The more forceful the contraction, the greater distance and vertical height the athlete can propel into the air (Chen-Yu et al., 2011).

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If tendinopathy is present, the strain associated with these repetitive movements may lead to further pain and diminished performance or further injury (Hale, 2005; Kulig, et al., 2013; Peers &Lysens, 2005). Among the many different aspects of performance, this condition may alsoaffect the range of motion (ROM), strength,and power produced at the knee and dynamic balance.

To prevent the ill effects of this condition, an intervention is needed because, if left untreated, the tendon may potentially rupture or damage can occur to the particular, ligamentous, or meniscal structures of the knee joint(Scott & Chang, 2008). In clinical practice, there are many taping techniques described and available to treat various knee conditions; the two most common include the McConnell taping technique (McConnell, 1996) and the Kinesio taping method(Kase, Wallis, &Kase, 2013). The latter approach uses Leukotape (LT), which is a non-elastic adhesive that may reduce the many symptoms associated with acute patellar tendinopathy (Briem, Eythorsdottir, Magnusdottir, Palmarsson, Runarsdottir, &Sveinsson, 2011; Campolo, Babu, Dmochowska, Scariah, &Varughese, 2013). The adhesive properties of the tape, method of application, and direction of pull result in realignment of the patella into its normal position in the trochlear notch and facilitation of increased quadriceps muscle activity. It is proposed that this may aid in optimal force distribution and elimination of any muscular imbalances or pain present (Campolo et al., 2013; McConnell, 1996). Kinesio tape (KT), on the other hand, is unique because it is flexible yetsupportive when applied(Kase et al., 2013).The clinical utility of this tape has been associated with many desirable effects like the reduction in pain and swelling, as well as increased joint mobility(Ujino, Eberman, Kahanov, Renner, & Demchak, 2013)

To date, few comparative studies have examined the effects of different types of therapeutic tape on athletes and non-athletes suffering from acute patellar tendinopathy. Therefore, the purpose of this preliminary proof of concept investigation was to determine the effectiveness of therapeutic taping on pain, ROM, power, balance, and strength in individuals with and without this condition. It was hypothesized that therapeutic tape (KT and LT) would reduce pain and improve knee ROM, power, balance, and strength when compared to the no tape (NT) condition in the affected athletes. Furthermore, no change was expected between or within the comparison group consisting of healthy non-athletes.

## 2.0 Methods

### 2.1. Participants

Purposive sampling was implemented (Trochim, 2005). Following ethical approval from the institution, the participants were recruited from the varsity basketball and volleyball teams and general student population. A team practice was attended to distribute recruitment letters to athletes, whereas the comparison group was recruited via posters distributed around the university. To be included in the affected group, participants had to be at least 18 years of age and diagnosed with acute patellar tendinopathy by a healthcare provider. The comparison group consisted of male and female non-athletes, who were at least 18 years of age and not currently diagnosed with a musculoskeletal injury. Participants were excluded if they were experiencing any additional lower quadrant injuries or conditions, had chronic knee pain, allergies to athletic tape, received corticosteroid injections in the lower quadrant within the past year, or had knee surgery within the past five years. A total of eight participants were recruited, three diagnosed with acute patellar tendinopathy (3 females, age 20.0 $\pm$1.0 years, height 191.0 $\pm$20.0 cm, weight 69.4 $\pm$10.8 kg) and five without the condition (3 males and 2 females, age 22.8 $\pm$1.3 years, height 173.8 $\pm$ 9.0 cm, weight 79.5 $\pm$18.6 kg).

### 2.2. Procedure

After informed consent was obtained, participants committed to three, 30-minute testing sessions with at least one day of rest between them. One session was allocated to each of the following conditions: NT, KT, and LT. The baseline testing session involved NT and the subsequent taping sessions were randomized for each participant. All testing was conducted in the laboratory at the respective institution by the primary researcher who has extensive training in the use of therapeutic taping. During the initial NT session, participants were informally interviewed about his/her injury. Following the interview, the participant’s pain level was measured using the Numeric Pain Rating Scale (NPRS). After this was completed, the ROM and strength of the knee joint, power, and balance measures were tested. Pain levels were also measured once again after the participant performed the balance task. Once all the tasks were performed, the participant was asked to return the next day to continue with subsequent testing.

During the KT and LT sessions, the application of the tape commenced after the initial pain level was recorded. The participant then followed the same procedures as the initial session and the tape was removed at the end of each session. To determine the testing leg of those without the condition, a coin was flipped with heads indicating the right leg and tails indicating the left leg.

### 2.3. Measures

The perception of pain was measured using the NPRS(Hawker, Mian, Kendzerska, & French, 2011)which consists of an 11-point scale with zero indicating "no pain", one to three indicating "low pain," four to six indicating "moderate pain," and seven to ten indicating "severe pain." Knee ROM(°) was assessed with a standard goniometer following the procedures adapted from Reese and Bandy(2010). All measurements were taken with the participant in a supine lying position. For knee flexion, the goniometer axis was aligned on the lateral epicondyle of the femur. The proximal arm of the goniometer was placed along the long axis of the femur and pointed towards the greater trochanter. The distal arm was placed along the long axis of the fibula and pointed towards the lateral malleolus. With the hip and knee flexed, the participant was instructed to move the heel toward the buttockuntil maximum knee flexion was achieved and the measurement recorded. This process was repeated for knee extension, but the participant was instructed to move the heel forward, straightening the knee. The mean of three trials was used in the subsequent analysis, for each taping condition.

Power was measured using a counter movement vertical jump procedure (Markovic, Dizdar, Jukic, & Cardinale, 2008). Before performing the jump, the participant's body mass was measured using a weight scale. The participant stood with his/her dominant arm facing the wall with both feet flat on the ground. A piece of tape was then wrapped around the distal phalanx of the participant's third and fourth finger. He/she then extended the dominant hand as high as possible and touched the wall using these two fingers. The tape was adhered to the wall marking the highest point reached by the participant. Once the reach height was recorded, the participant was instructed in the proper jumping technique and given one practice trial. The participant was cued to jump as high as possible and the highest point touched on the wall was recorded with another piece of tape, replicating the previous taping procedure. The participant was asked to use countermovement of the arms to project the body upwards. The mean value of three formal trials (cm) was used to determine peak leg power (Watts) as calculated by the equation used in previous research by Bicici, Karatas, and Baltaci (2012) and Sayers, Haracjiewicz, Harman, andFrykman (1999). The formula used to calculate power was:

**Power** = ([60.7 x (Jump Ht. cm.)] + [45.3 x (Body Mass kg.)] – 2055)

The Star Excursion Balance Test(SEBT) was used to measure dynamic balance(Sayerset al., 1999).Participants stood with his/her affected or test leg over the center of the grid. The grid had eight lines and each of these lines extended at 45° increments in the anterior, anterolateral, anteromedial, posteromedial, posterior, posterolateral, medial, and lateral directions. Before the formal testing was completed, the participant's leg length was measured to account for inter-individual differences. Once the affected leg was placed over the center mark, the participant's opposite leg was extended as far as possible on each line followinga clockwise direction. In order to complete the trial, the participant had to touch the ground with the toe of the reaching leg. A total of 24 attempts were carried out, with three reaches in each of the eight directions. A coloured piece of tape was placed at the point of contact between the toe and the ground. After each reach, a 30-second break was allotted to measure the distance between the center mark and tape. This value was then divided by the participant's leg length and the mean of the three trials (%) was used for the subsequent analysis.

Lastly, knee strength was measured using a Baseline Electronic Hydraulic Push-Pull Dynamometer (Bohannon, 2005) according to the procedures outlined by Andrews, Thomas, and Bohannon (1996). Measurements were obtained while the participant was in a seated position with the knee flexed to 90°. The dynamometer was placed on the anterior surface of the distal one third of the lower leg. When prompted, the participant attempted to extend the knee while receiving counter pressure from the dynamometer. After five seconds of counter pressure, the peak strength was recorded. This process was repeated for knee flexion, but the dynamometer was placed on the posterior aspect of the distal third of the lower leg. Three formal trials (lbs) for each movement were carried out, with one minute of rest between them; the mean value was used in the subsequent statistical analysis.

### 2.4. Taping Procedure

Application of the LT followed the McConnell taping technique (McConnell, 1996). The Hypafix tape was measured and applied over the anterior aspect of the patella. Small portions of the Hypafix tape extended past the medial and lateral sides of the patella and were firmly anchored to the skin. Once this procedure was completed, the LT was applied to the central portion of the patella. The tape was then tensioned, tilting the patella in a medial direction. The remainder of the tape was then laid down medially over the surrounding tissues. In order to correct the glide of the patella, the tape was held with tension in one hand while the other hand glided the patella medially. The tissues surrounding the knee were gathered upwards and the remainder of the LT was applied (Figure 1).

**Figure 1:** McConnell taping technique with LT.

The method of application for the KT replicated the U-Strip technique outlined by Pope, Baker, and Grind staff (2010) and Kase and colleagues (2013). The length of the tape required was measured using the distance from the medial to lateral portion of the patella. With the participant in supine lying and the knee fully extended, the KT was applied over the base of the patella. Approximately 50% paper off tension was applied to the KT. A downward pressure was then used when placing the KT over the lower portion of the patella. This tension was determined by stretching the KT until the wave pattern and spaces between the tape's fibers emerged. Once the tape was placed over the patella, the participant flexed his/her knee to a 90° position. As the participant flexed the knee, the remainder of the KT was laid down around the patella with slight tension (Figure 2).

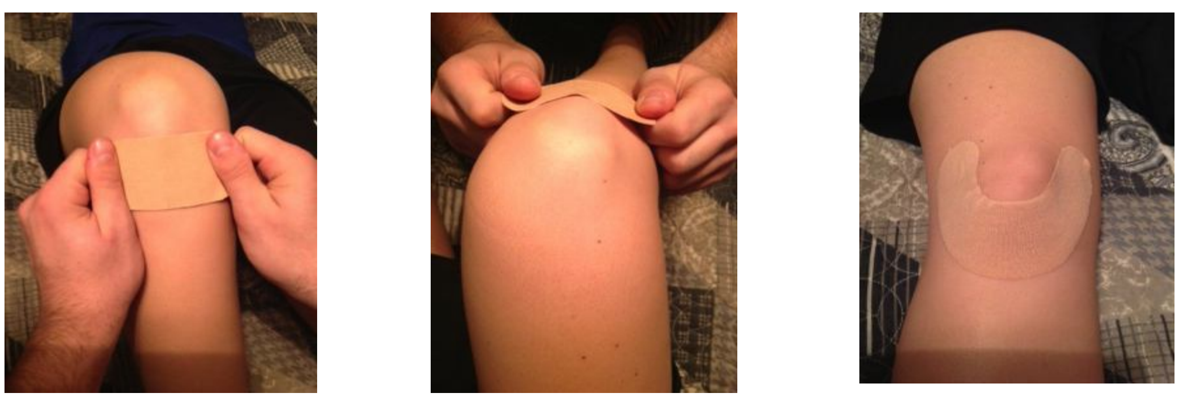

**Figure 2:** Kinsio taping technique with KT.

### 2.5. Design and Analysis

A Group (affected vs. comparison) xCondition (KT; LT; NT) mixed factorial design, with repeated measures on the second factor was implemented. A Wilcoxon Signed Ranks was conducted to examine intra-group differences across the conditions, whereasa Mann-Whitney U Test was used to examine inter-group differences. The alpha level was set at .05.

## 3.0 Results

### 3.1. Pain

In terms of intra-group comparisons (Table 1), the affected groupshowed no statistically significant differences in pre-pain levels when KT and LT ($Z$ = -4.7, $p$ = .65), KT and NT ($Z$ = -1.34, $p$ = .10), and LT and NT conditions were compared ($Z$ = -1.3, $p$ = .18). The same was true for the comparison group regardingthe KT and LT ($Z$ = -1.0, $p$ = .31), KT and NT ($Z$ = -1.0, $p$ = .31), and LT and NTcomparisons ($Z$ = -1.0, $p$ = .31). With regards to post-pain levels, the affected group once again revealed no statistical differences between KT and LT ($Z$ = -4.7, $p$ = .65), KT andNT ($Z$ = -1.6, $p$ = .10), or LT and NT conditions ($Z$ = -1.6, $p$ = .10). Also, no differences were found for the comparison group when KT and LT ($Z$ = -1.0, $p$ = .31), KT and NT ($Z$ = -.47, $p$ = .65), or LT and NT ($Z$ = -1.3, $p$ = .18) were compared. In terms of inter-group differences, particularly at the post-test condition, the differences betweenthe groups were significant forall three taping conditions (KT ($U$ = .50, $p$ = .02); LT ($U$ = 0, $p$ = .01); NT ($U$ = 0, $p$ = .02).

**Table 1:** ***Pre and Post Pain Levels in Comparison (1-5) and Affected (6-8) Participants with Different Taping Conditions***

| | Pre | | | Post | | |
|---|---|---|---|---|---|---|
| Participant | KT | LT | NT | KT | LT | NT |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 2 | 0 | 0 | 3 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 2 | 0 | 0 | 0 | 1 | 1 |
| M (SD) | 0.4 (0.8) | - | 0.4 (0.8) | - | 0.2 (0) | 0.8 (1.3) |
| 6 | 4 | 5 | 6 | 4 | 4 | 6 |
| 7 | 3 | 1 | 4 | 3 | 1 | 6 |
| 8 | 2 | 2 | 2 | 2 | 3 | 5 |
| M (SD) | 3.0 (1.0) | 2.6 (2.0) | 4.0 (2.0) | 3.0 (1.1) | 2.6 (1.5) | 5.6 (0.5) |

*Note.* KT = Kinesio tape; LT = Leukotape; NT = No tape

### 3.2. Range of Motion

The intra-group analyses of knee flexion revealed no significant differences in the affected group when ROM was compared between KT and LT ($Z$ = -.44, $p$ = .65), KT and NT ($Z$ = -1.3, $p$ = .18), and LT and NT conditions ($Z$ = -.44, $p$ = .65) (Table 2). Similar results were found within the comparison group, as no significant differences were revealed when KT and LT ($Z$ = -1.4, $p$ = .14), KT and NT ($Z$ = -.36, $p$ = .75), and LT and NT conditions ($Z$ = -1.8, $p$ = .06) were compared.The analysis of inter-group comparisons once again showed no significant differences between groups for KT ($U$ = 2.0, $p$ = .53), LT ($U$ = 2.5, $p$ = .53), and NT conditions ($U$ = 3.0, $p$ = .80). The amount of knee flexion range was lowest with the application of LT in both groups.With regards to knee extension, the analyses of intra-group comparisons showed that the affected group exhibited no significant differences between KT and LT ($Z$ = -.44, $p$ = .65), KT and NT ($Z$ = -1.4, $p$ = .15), or LT and NT conditions ($Z$ = -.44, $p$ = .65). The comparison group also exhibitedno significant differences between KT and NT($Z$ = -1.6, $p$ = .10), KT and LT ($Z$ = -1.8, $p$ = .06), or LT and NT ($Z$ = -.44, $p$ =.65) conditions. With respect to inter-group comparisons, in line with knee flexion, no statistically significant differences were found between the groups for KT ($U$ = 1.5, $p$ = .23), LT ($U$ = .5, $p$ = .10), and NT conditions ($U$ = 0, $p$ = .13).

**Table 2:** ***Contrast of Knee Range of Motion (°) Performances in Comparison (1-5) and Affected (6-8) Participants with Different Taping Conditions***

| | Flexion | | | Extension | | |
|---|---|---|---|---|---|---|
| Participant | KT | LT | NT | KT | LT | NT |
| 1 | 126.0 | 120.6 | 126.6 | 6.0 | 7.3 | 8.6 |
| 2 | 128.3 | 126.0 | 128.6 | 4.0 | 4.6 | 4.0 |
| 3 | 148.3 | 132.3 | 143.0 | 6.0 | 4.6 | 6.6 |
| 4 | 119.3 | 120.3 | 120.6 | 3.6 | 4.0 | 9.0 |
| M | 130.4 | 124.8 | 129.7 | 4.9 | 6.8 | 7.0 |
| (SD) | (12.4) | (5.6) | (9.4) | (1.2) | (1.8) | (2.2) |
| 7 | 139.3 | 120.6 | 128.0 | 3.0 | 4.6 | 2.3 |
| 8 | 140.6 | 145.3 | 138.3 | 4.0 | 2.6 | 3.3 |
| M | 139.9 | 132.9 | 133.1 | 3.5 | 3.6 | 2.8 |
| (SD) | (0.9) | (17.4) | (7.2) | (0.7) | (1.4) | (0.7) |

*Note.* KT = Kinesio tape; LT = Leukotape; NT = No tape

### 3.3. Power

The intra-group analyses revealed no significant differences in the affected group when power was compared between KT and LT ($Z$ = -.81, $p$ = .41), KT and NT ($Z$ = -.53, $p$ = .59), or LT and NT conditions ($Z$ = -.44, $p$ = .65) (Table 3). Similar results were found for the comparison group asno significant differences were found between KT and LT ($Z$ = -1.8, $p$ = .06), KT and NT ($Z$ = -1.4, $p$ = .13), or LT and NT ($Z$ = -.13, $p$ = .89). In terms of inter-group comparisons, the analysis revealed no statistical differences between groups for KT ($U$ = 4.0, $p$ = .39), LT ($U$ = 5.0, $p$ = .57), and NT ($U$ = 5.0, $p$ = .45).

**Table 3:** ***The Amount of Power (Watts) Produced in Comparison (1-5) and Affected (6-8) Participants with Different Taping Conditions***

| **Partic** | **KT** | **LT** | **NT** |
|---|---|---|---|
| 1 | 3109.3 | 3006.1 | 2723.2 |
| 2 | 4559.6 | 4559.6 | 4717.4 |
| 3 | 3680.4 | 3601.5 | 3486. 7 |
| 4 | 6064.7 | 5801.7 | 5862.4 |
| 5 | 4584.9 | 4342.1 | 4463.5 |
| **M *(S*** | **4399.7 *(111*** | **4262.2 *(105*** | **4441.6 *(129*** |
| 6 | 4363.9 | 4242.5 | 4339.6 |
| 7 | 3594.7 | 3716.1 | 3655.4 |
| 8 | 3376.3 | 3194.2 | 3194.2 |
| **M *(S*** | **3778.3 *(518*** | **3717.6 *(52*** | **3729.7 *(576*** |

*Note.* KT = Kinesio tape; LT = Leukotape; NT = No tape

### 3.4. Balance

In terms of the affected group, no intra-group differences were evident in the balance domain ($p$ = .10 - 1.0) when each of the eight directions were compared for the KT, LT, and NT conditions (Table 4). The same was true for the comparison group as no significant differences were found across directions and taping conditions ($p$ = .06 – 1.0). In regards to inter-group comparisons, statistically significant differences were found in the anterior, anterolateral, anteromedial, posterolateral, and lateral directions with KT ($U$ = 0, $p$ = .02). Similar results were found with LT when the anterior, anterolateral, anteromedial, posteromedial, medial, lateral ($U$ = 0, $p$ = .02) and posterior directions ($U$ = 0.5, $p$ = .03) were examined. The analysis of the NT condition revealed significant differences between groups in the posterior, posterolateral, medial, and lateral directions ($U$ = 0, $p$ = .02).

**Table 4:** ***Contrast of Taping Conditions on Balance with Comparison and Affected Groups***

| | | | Condition | | | |
|---|---|---|---|---|---|---|
| | KT | | LT | | NT | |
| | **M** | ***D*** | **M** | ***D*** | **M** | ***D*** |
| **Balance (%)** | | | | | | |
| Comparison | | | | | | |
| A | 24.7 | *.6* | 25.2 | *9.6* | 20.4 | *7.9* |
| AL | 21.6 | *4.1* | 19.8 | *4.1* | 17.1 | *2.5* |
| AM | 27.0 | *5.7* | 27.4 | *7.9* | 19.0 | *2.8* |
| PM | 17.0 | *9.0* | 16.7 | *7.0* | 15.1 | *.9* |
| P | 09.6 | *7.8* | 12.1 | *5.1* | 10.1 | *6.9* |
| PL | 05.9 | *1.1* | 03.6 | *8.9* | 02.2 | *1.6* |
| M | 25.9 | *8.2* | 26.4 | *7.5* | 28.9 | *4.9* |
| L | 02.0 | *2.6* | 8.5 | *1.0* | 04.4 | *4.2* |
| Affected | | | | | | |
| A | 1.3 | *8.3* | 0.8 | *6.9* | 0.8 | *7.6* |
| AL | 0.4 | *7.3* | 0.6 | *3.4* | 1.3 | *6.6* |
| AM | 1.8 | *7.6* | 1.3 | *6.7* | 9.5 | *7.5* |
| PM | 4.9 | *8.8* | 6.6 | *4.9* | 4.8 | *5.3* |
| P | 4.2 | *9.0* | 0.4 | *2.8* | 3.9 | *3.7* |
| PL | 2.1 | *1.4* | 1.4 | *4.9* | 5.9 | *4.3* |
| M | 7.3 | *9.9* | 4.1 | *6.1* | 2.9 | *3.2* |
| L | 0.4 | *6.6* | 2.3 | *0.0* | 8.6 | *0.2* |

*Note.* KT = Kinesio tape; LT = Leukotape; NT = No tape; A = Anterior; AL = Anterolateral; AM = Anteromedial; PM = Posteromedial; P = Posterior; PL = Posterolateral; M = Medial; L = Lateral

### 3.5. Strength

The intra-group analyses for flexor strength revealed no significant differences within the affected group whenKT and LT (*Z* = -1.0, *p* = .59), KT and NT (*Z* = -.53, *p* = .59), or LT and NT (*Z* = 0, *p* =1.0) conditions were compared (Table 5). The same was true for the comparison group, as no significant differences were found between KT and LT (*Z* = -.94, *p* = .34), KT and NT (*Z* = -.67, *p* = .50), or LT and NT conditions (*Z* = -3.6, *p* = .46). In terms of inter-group comparisons, once again, statistical analysis revealed no differences for any of the conditions (KT (*U* = 2.0, *p* = .10); LT (*U* = 2.0, *p* = .10); NT (*U* = 4.0, *p* = .29)). Intra-group analyses of extensor strength revealed no statistical differences in the affected group between KT and LT (*Z* = -.53, *p* = .59), KT and NT (*Z* = -1.6, *p* = .10), or LT and NT conditions (*Z* = -1.0, *p* = .28) (Table 5). Similarly, no statistical differences were found between KT and LT (*Z* = -.94, *p* = .34), KT and NT (*Z* = -1.8, *p* = .06), or LT and NT (*Z* = -.40, *p* = .68) for the comparison group. In terms of inter-group comparisons, no differences in extensor strength were also found with KT (*U* = 3.0, *p* = .18), LT (*U* = 3.0, *p* = .25), or NT (*U* = -1.2, *p* = .22) conditions.

**Table 5:** ***Contrast of Knee Strength Performances (lbs) in Comparison (1-5) and Affected (6-8) Participants with Different Taping Conditions***

| | Flexion | | | Extension | | |
|---|---|---|---|---|---|---|
| **Partici** | **KT** | **LT** | **NT** | **KT** | **LT** | **NT** |
| 1 | 31.6 | 28.2 | 30.8 | 30.2 | 24.1 | 29.9 |
| 2 | 51.5 | 51.7 | 33.5 | 46.5 | 47.2 | 38.7 |
| 3 | 39.8 | 42.7 | 45.8 | 41.7 | 43.4 | 44.3 |
| 4 | 59.3 | 61.4 | 51.6 | 55.5 | 49.8 | 37.9 |
| 5 | 57.2 | 59.4 | 60.4 | 57.2 | 59.0 | 67.8 |
| **M** | **47.8** | **48.7** | **44.4** | **46.2** | **44.7** | **43.7** |
| ***(SD)*** | | | | ***(10.9)*** | | ***(14.*** |
| 6 | 28.2 | 23.0 | 18.5 | 34.4 | 33.3 | 24.4 |
| 7 | 38.3 | 32.5 | 33.6 | 38.6 | 37.1 | 38.3 |
| 8 | 34.9 | 36.8 | 39.7 | 41.2 | 40.5 | 32.2 |
| **M** | **33.8** | **30.7** | **30.6** | **38.0** | **36.9** | **31.6** |
| ***(SD)*** | ***(5.1*** | ***(7.0*** | ***(10.*** | ***(3.4)*** | ***(3.6*** | ***(6.9*** |

*Note.* KT = Kinesio tape; LT = Leukotape NT = No tape

## 4.0 Discussion

### 4.1. Pain

Pain is considered to be the primary symptom of acute patellar tendinopathy (Rio et al., 2010; Williams, Whatman, Hume, & Sheerin, 2012) and previous research has reported that therapeutic tape may serve as a potential treatment for pain when applied to the knee for specific conditions(Campolo et al., 2013). The results of the current study did not confirm thisfinding,as no substantial differences were found within the affected and comparison groups when comparing pre- and post-pain levels, across the taping conditions (Table 1). This may be attributed to the fact that participants were experiencing little to no pain at the initial level of assessment, thus,leaving minimal opportunity for improvement. Although pain did not decrease within the affected group, it should be noted that it was also not increased despite the fact that participants were engaged in several ballistic type tasks for testing which may serve as aggravating factors commonly in individuals with this overuse disorder. Thus, it appears that the application of therapeutic tape may prevent thefurther increase in pain, which could possibly stem from the tapes' structural characteristics and the different methods of application (Farrar, Portenoy, Berlin, Kinman, & Strom, 2000; Kase et al., 2013; McConnell, 1996; Williams et al., 2012).

For example, the McConnell taping technique implements a mechanical correction to medially glide and tilt the patella, equalizing the force distribution within the quadriceps muscles(McConnell, 1996). On the other hand, the application of KT incorporated a tendon correction, which is believed to decrease pressure over the tendon and taped area (Kase et al., 2013). From a clinical standpoint, the fact that both tapesreduced further painin comparison to the NT condition represents a valuable outcome. This may be beneficial for an individual reporting knee pain such as an athlete who is continuing to competeat his/her sport, or a patient that is attempting to complete a set of prescribed active exercises as part of the rehabilitation process. This may serve as an important consideration and clinical rationale for the use of LT or KT under these conditions. As for the comparison group, few participants were experiencing knee pain; therefore, the lack of statistical differences is intuitively pleasing. Regarding inter-group comparisons, substantial differences in pain were measured across the taping conditions. These findings were expected, as only one group was experiencing pain. Ultimately, it appears that therapeutic tape does not substantially decrease pain in varsity athletes with acute patellar tendinopathy. However, the application of therapeutic tape and its effect on pain may be context specific and beneficial for preventing further painwhen specific types of tasks are being performed.

### 4.2. Range of Motion

The application of therapeutic tape had minimal effect on knee flexor ROM within the affected group (Table 2). These results are consistent with Sanzo, Zerpa, Przysucha, andVasilu (2014)who found no improvements with KT, butreported significantly decreased knee flexion with LT. The authors believed thatthe structural rigidity of LT prevented the participants from achieving maximal knee flexion range. Although the current study did not find statistically significant changes in knee flexor ROM, LT appeared to reduce knee flexor ROM the greatest in comparison to KT and NT. It is likely that the discrepancies betweenthe past and current results are attributed to the population demographics, asSanzo et al.(2014) testedhealthyas opposed to a pathological population.Furthermore, it is believed that individuals with acute patellar tendinopathy experience reduced ROMas a result of pain influences(Renström& Woo, 2007). Within the current study, only low to moderate pain levels were reported among the affected participants. Such low measures of pain do not appear to reduce knee mobility and could explain why participants were able to achieve optimal ROM during each of the taping conditions.

In terms of the comparison group, it was expected that therapeutic tape would have little effect on ROM, based on the absence of pathology. Furthermore, differences in knee flexion were expected between the comparison and affected groups. This was also not the case, as performances were comparable across the tapingconditions. These results may once again be attributed to the low pain levels reported within the affected group, as the pain may not have been enough to substantially reduce knee flexion. As for knee extensionperformances (Table 2), no substantial differences were found across the taping conditions within the affected and comparison group and these results are consistent with previous findingsreported by Sanzo et al. (2014).

### 4.3. Power

Therapeutic tape does not appear to increase power within the affected and comparison groups, as performances were comparable across the taping conditions (Table 3).

These findings are consistent to those previously reportedby Nunes, De Noronha, Cunha, Ruschel, and Borges (2013)who reported that therapeutic tape was not sufficient enough to elicit an underlying sensory response, including the stimulation of the mechanoreceptors and Golgi-tendon organs in the structures underlying the tape(Kase et al., 2013).Moreover, trends within the comparison and affected groups revealed decreases in performance with LT when compared to the baseline NT condition. It is possible that the structural characteristics of the tape contributed to these findings. The rigidness of the LT may have prevented the participants from achieving sufficient knee flexion range, thereby limiting his/her capability to forcefully extending the knee during the jumping maneuver. From a clinical standpoint, if therapeutic taping were to be implemented as a treatment intervention for athletes with acute patellar tendinopathy, KT may be the optimal selection when considering that this tape limited knee flexor ROM the least and several participants generated greater power with its application comparted to NT or LT. The elastic properties of KT allow it to be supportive yet allow the individual to maintain optimal function in the knee (Kase et al., 2013), and potentially positively influencing the amount of power being generated. Furthermore, no substantial differences were found across conditions regarding inter-group comparisons. These results are surprising when considering that members of the comparison group were injury free and did not have any limitations in the amount of power being produced at the knee. Overall, it appears that the application therapeutic tape has limited effect on power production but further study is required. Healthcare providers that are considering therapeutic tape as a supplementary tool or treatment option, should consider the tapes structural characteristics and the amount of range required in the knee for the functional or sport specific task before the application and choice of the tape type.

### 4.4. Balance

The status of balance control, as inferred from the SEBT, remained unchanged in both groups when therapeutic tape was applied at the knee (Table 4).These findings were unexpected for those within the affected group, given that the application of therapeutic tape was intended to increase support at the knee and potentially stimulate underlying sensory systems when performing the directional movements (Kase et al., 2013; McConnell, 1996). Similar to power, it is plausible that the effects of therapeutic tape are not robust enough to elicit an underlying sensory response, resulting in increased balance performances (Nunes et al., 2013). In terms of previous research, the study's current findings are in line with Bicici et al.(2012) who measured the effects of KT on individuals who sustained inversion ankle sprains. Thus, it appears that regardless of the joint or condition measured, taping does not appear to improve balance performances when measured in certain pathological populations.

In terms of inter-group comparisons, substantial differences were found for the majority of directions with therapeutic tape. These findings were expected, considering that only one group was symptomatic and experiencing movement impairments in the lower quadrant. The results emerging here are not in line with Nakajima and Baldridge(2013) who found no considerable differences in balance performances during the SEBT between an experimental and control group. The experimental group consisted of healthy participants who received KT with applied tension on the ankle joint. Those in the control group also received KTbut with no tension in the tape. The discrepancies between the current study and Nakajima and Baldridge(2013)are likely attributed to the lack of a comparison group consisting of a pathological population and the taping techniques measured. Therefore, it appears that regardless of the population (e.g., healthy versus pathological), therapeutic tape has no effect on balance and the differences between the groups are likely attributed to movement restrictions within the affected group.

### 4.5. Strength

When observing the effects of therapeutic taping on muscular strength, no substantial differences were found within the affected group (Table 5). At the group and individual level of analyses, greater knee flexor (participants 6 and 7) and extensor strength (participants 6-8) was generated with the application of KT when compared across the taping conditions. These findings do not support those previously reported by Osorio et al.(2013) who found significant improvements in strength with the application of therapeutic tape.

The inconsistencies from the current study are likely attributed to the method of assessing strength, as the latter study examined isokinetic and not isometric knee strength. Isometric strength is generated through static movements whereas isokinetic strength is generated through dynamic movements (Fahey, Insel, Roth, & Wong, 2007). Therefore, the application of therapeutic tape may have a different effect on strength when performing dynamic versus static tasks. Also, the presence of swelling within the tendon area may have contributed to the current findings.

Swelling is a commonly reported symptom of acute patellar tendinopathy and the presence of knee swelling has been associated with decreased muscular strength resulting from inhibition of the quadriceps muscles (Renström & Woo, 2007; Spencer, Hayes, & Alexander, 1984).All affected participants were experiencing swelling at the time of testing; however, levels were moderate for some participants in comparison to others and this may explain why some participants generated greater strength when compared to others. When LT was applied, the presence of swelling may have reduced the overall effectiveness of the McConnell taping technique via inhibition of the muscle. The LT technique was applied to the patella femoral joint region and not directly to the patellar tendon and this may not have affected the swelling in this region. Additionally, the U-strip technique with KT may not have provided sufficient compression due to the elastic nature of the tape to reduce the amount of swelling in the area, thus, preventing any underlying fluid from dissipating (Kase et al., 2013).In terms of the comparison group, it was hypothesized that therapeutic tape would have minimal effect on strength due to the absence of knee pathology. This was confirmed by the data where knee flexion and extension performances were comparable across taping conditions (Table 5), and this is consistent with previous research (Sanzo et al., 2014). Similar results were also found regarding inter-group comparisons, as minimal differences in performance were found across the taping conditions. These results are surprising when considering that participants in the comparison group were generating approximately 10 lbs more strength than those in the affected group. The presence of symptoms (e.g.,swelling) within the affected group may have reduced muscular contraction when performing the flexion and extension movements (Renström & Woo, 2007; Spencer et al., 1984). Thus, the implementation of additional sophisticated laboratory equipment (electromyography, is okinetic analysis) in combination with the suggested clinical measures may be needed to detect the effects of therapeutic taping on muscular strength.

## 5.0. Conclusion

The purpose of this preliminary proof of concept investigation was to determine the effectiveness of therapeutic taping on pain, ROM, power, balance, and strength in individuals with and without acute patellar tendinopathy. From a clinical standpoint intriguing patterns have emerged, and it appears that both KT and LT may have an effect on some variable for certain individuals. However, future research should consider the implementation of a placebo condition with a larger sample of participants with both acute and chronic patellar tendinopathy in order to make any definitive conclusions regarding the effectiveness of the therapeutic tape.

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