# THERAPEUTIC PATELLAR TAPING TECHNIQUES EFFECT LOWER EXTREMITY RUNNING KINEMATICS IN INDIVIDUALS WITH PATELLOFEMORAL PAIN SYNDROME

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This study investigated the effects of patellar taping (McConnell's Medial Glide, MMG; Mechanical Correction with Tension in the Base, MCT; no tape, NT) on lower extremity kinematics in runners with and without patellofemoral pain syndrome (PFPS). Twenty healthy individuals and 12 with PFPS participated. Significant taping effects were found for hip flexion ($p$=.0001) and knee flexion angles ($p$=.0001) at initial contact and peak hip flexion angles during swing ($p$=.003). MMG produced more flexion than the MCT and NT. Peak knee flexion angles during stance ($p$=.036) and flight time ($p$=.010) revealed significant taping effects, with MMG resulting in more flexion and shorter flight times than NT. A significant taping effect was seen for peak knee flexion angle during swing ($p$=.010), with MCT resulting in less flexion than MMG and NT. The application of patellar taping may impact on running mechanics.

**KEY WORDS:** Leukotape, Kinesio Tape, biomechanics, gait.

**INTRODUCTION:** Running is a popular form of physical activity; however, it has been linked to multiple lower extremity overuse injuries, with 40% of them occurring at the knee (Ferber & Macdonald, 2014). Specifically, patellofemoral pain syndrome (PFPS), characterized by pain over the anterior aspect of the knee, accounts for 46 – 62% of those injuries (Ferber & Macdonald, 2014). A commonly used treatment for PFPS is therapeutic patellar taping. Two popular techniques that have emerged over the years include McConnell's Medial Glide (MMG) with Leukotape and Mechanical Correction with Tension in the Base (MCT) with Kinesio Tape. However, the number of studies examining the effects of therapeutic taping on lower extremity kinematics is limited and contradictory due to different study designs and methodologies used, and varied taping techniques and activities used. Furthermore, there is limited to no research comparing different therapeutic taping techniques and none have investigated the effects during running. Given that running has clearly been linked to PFPS (Ferber & Macdonald, 2014), and that therapeutic taping has become a commonly used treatment for PFPS (Callaghan & Selfe, 2012), there is a need to identify its effect on angular displacements and time during running. Therefore, the purpose of this study was to investigate the effects of therapeutic patellar taping techniques (MMG and MCT) compared to no tape (NT) on lower extremity kinematics during the different phases of the running gait cycle in runners with and without PFPS.

**METHOD:** After ethical approval was received from the academic institution, 32 shod runners who ran at least 30 minutes per day, for a minimum of three days per week were recruited to participate (Table 1).

**Table 1**
**Participant Characteristics**

| | Healthy (n=20) | | Patellofemoral Pain Syndrome (n=12) | |
|---|---|---|---|---|
| | Females (n=10) | Males (n=10) | Females (n=8) | Males (n=4) |
| Age (years) | 23.3 ± 3.0 | 26.1 ± 7.3 | 27.6 ± 7.4 | 30.0 ± 11.4 |
| Height (cm) | 172.4 ± 4.5 | 181.7 ± 6.4 | 169.6 ± 4.6 | 180.7 ± 10.1 |
| Weight (kg) | 63.5 ± 6.5 | 76.5 ± 7.2 | 64.6 ± 7.5 | 80.3 ± 7.3 |

The order of the taping interventions (MMG; MCT; NT) were determined via a randomization process, and were applied to the left knee of those in the healthy group and to the affected knee of those with PFPS. In the case of bilateral PFPS, the left leg was selected for standardization.

To maintain consistency, only the qualified primary researcher completed the taping interventions. For MMG, a thin layer of Hypafix was initially laid over the patella prior to applying Leukotape from the lateral to the medial aspect while simultaneously gliding the patella medially (McConnell, 1986). The MCT utilized Kinesio Tape and involved anchoring a Y-strip with a long base to the lateral aspect of the knee, applying 50-70% stretch and pressure until the lateral border of the patella was reached, in which case the tails were applied along the superior and inferior borders of the patella with 15-25% stretch (Kase, Wallis, & Kase, 2013).

Reflective markers were then applied and followed a modified Helen Hayes marker set (Richards, 2008). The first and second markers were placed on the outside of the running shoe on the base of the fifth metatarsal and middle of the calcaneus. The third, fourth, and fifth markers were positioned on the lateral malleolus, lateral femoral epicondyle, and the greater trochanter, respectively. The sixth and seventh markers were referred to as 'wands' and were placed over the lateral aspect of the femur and tibia. Following marker placement, participants were asked to run shod foot on a Trackmaster treadmill. Participants began with a 5-minute treadmill warm up at a self-selected pace below 3.22 m/s. The first taping intervention (previously determined via the randomization process) was then applied to the participant's leg, prior to running at the selected speed for 37 seconds. A 5-minute recovery period was then provided, during which the next taping intervention was applied. The same procedure was followed for the remaining taping interventions.

Video was collected using two Basler A601f cameras interfaced to a stationary 3D Peak Motus Software. The cameras were positioned perpendicular and diagonal to the treadmill and oriented to have the participants affected leg closest to the cameras. The cameras recorded at 100 Hz with the shutter speed set to 1/1000 of a second. A 32-point calibration tree and Direct Linear Transformation method were used to calibrate the space.

The data was also processed using Peak Motus, with three strides used in the analysis. The data was smoothed using a Butterworth digital filter. The optimal cut-off frequency was determined using the Jackson Knee Method (Jackson, 1979), and ranged from 5-10 Hz. The data was analyzed using descriptive statistics and mixed factorial ANOVAs ($p<.05$). Angular displacement and time were measured under different conditions. This included: hip flexion angle at initial contact (HFLEX-IC), knee flexion angle at initial contact (KFLEX-IC), peak hip adduction angle during stance, change in hip adduction angle during stance, peak knee adduction angle during stance, change in knee adduction angle during stance, change in hip medial rotation angle during stance, peak knee flexion angle during stance (PKFLEX-ST), peak hip flexion angle during swing (PHFLEX-SW), peak knee flexion angle during swing (PKFLEX-SW), as well as contact time (CT), and flight time (FT).

**RESULTS/DISCUSSION:** The significant results are highlighted in Figure 1a-f. Significant taping effects were found for knee flexion ($F$ (2, 60)=16.796, $p$=.0001) and hip flexion ($F$ (2, 60)=17.274, $p$=.0001) angles at initial contact with smaller angles being indicative of more flexion. MMG resulted in greater knee (M=164.85°, SD=3.43) and hip flexion (M=67.55°, SD=3.22) than the MCT (M=166.51°, SD=3.30; M=68.36°, SD=3.27) and NT conditions (M=166.66°, SD=2.90; M=68.50°, SD=3.09). This finding is in accordance with Powers et al. (1997) and Salsich et al. (2002) who found McConnell taping to increase knee flexion during walking and stair ambulation. The increased knee flexion seen at initial contact for MMG may have been attributed to the medial positioning of the patella with tape and may have allowed the patella to be more readily loaded through the activation of the quadriceps and gluteal muscles, allowing greater knee flexion, and consequently, greater force absorption (Powers et al. 1997). Furthermore, the increased hip flexion at initial contact for MMG may have been the result of increased knee flexion, thereby facilitating the absorption of impact on landing. There was no significant difference, however, between the mean knee and hip flexion angles at initial contact for the MCT and NT condition. This may be attributed to the tape and technique itself, which was designed to allow partial to full range of motion (Kase et al., 2013).Therapeutic taping also had a significant effect on peak knee flexion angles during stance ($F$ (2, 60)=3.509, $p$=.036), with MMG allowing for more knee flexion (M=137.82°, SD=5.40) than the NT condition (M=138.43°, SD=4.92, $p$=.040). Once again, this finding is in agreement with Powers et al. (1997) and Salsich et al. (2002), and may be explained by the rigidness of the tape repositioning the patella within the femoral trochlear groove allowing further knee flexion to occur during midstance. No significant difference was found between the MCT (M=138.41°, SD=5.21) and NT condition (M=138.43°, SD=4.92), which may once again be attributed to the elasticity of the Kinesio Tape. Similarly, there was also no significant difference between MMG (M=137.82°, SD=5.40) and MCT (138.41°, SD=5.21). Perhaps this non-significance was attributed to the amount of tension applied to the MCT, however, further investigation is warranted.

Therapeutic taping had a significant effect on peak knee ($F$ (2, 60)=4.964, $p$=.010) and hip flexion angles during swing ($F$ (2, 60)=6.556, $p$=.003). In fact, MMG (M=85.97°, SD=12.13) and NT (M=85.87°, SD=13.12) allowed for more knee flexion during swing than the MCT (M=87.61°, SD=11.95). The greater knee flexion associated with MMG is once again in agreement with Powers et al. (1997), and Salsich et al. (2002) and may impact on running economy and mechanics. However, this study found MMG to be comparable to the NT condition. Perhaps this is due to the large amount of knee flexion seen during swing, causing MMG to no longer be effective in repositioning the patella. The large amount of knee flexion during swing may have also caused the Kinesio Tape to stretch, eliminating the elasticity and making it quite rigid. Therefore, the now rigid MCT may have limited the amount of knee range of motion seen during swing. Surprisingly, therapeutic taping affected the hip slightly differently than the knee during swing. MMG allowed for more hip flexion (M=58.40°, SD=4.29) than the MCT (59.53°, SD=4.40, $p$=.011), however, MMG also allowed for more knee flexion than the NT condition (M=59.13°, SD=4.26, $p$=.031). The reason for this remains unclear. As a result, further research is required to determine the exact mechanism responsible for this difference. Therapeutic taping did not have a significant effect on peak hip and knee adduction angles during stance, as well as change in hip adduction, knee adduction, or hip medial rotation angles during stance. Since both taping techniques were applied from the lateral to medial aspect of the patella, the hip and knee joints ability to perform adduction and medial rotation movements should not have been impacted.

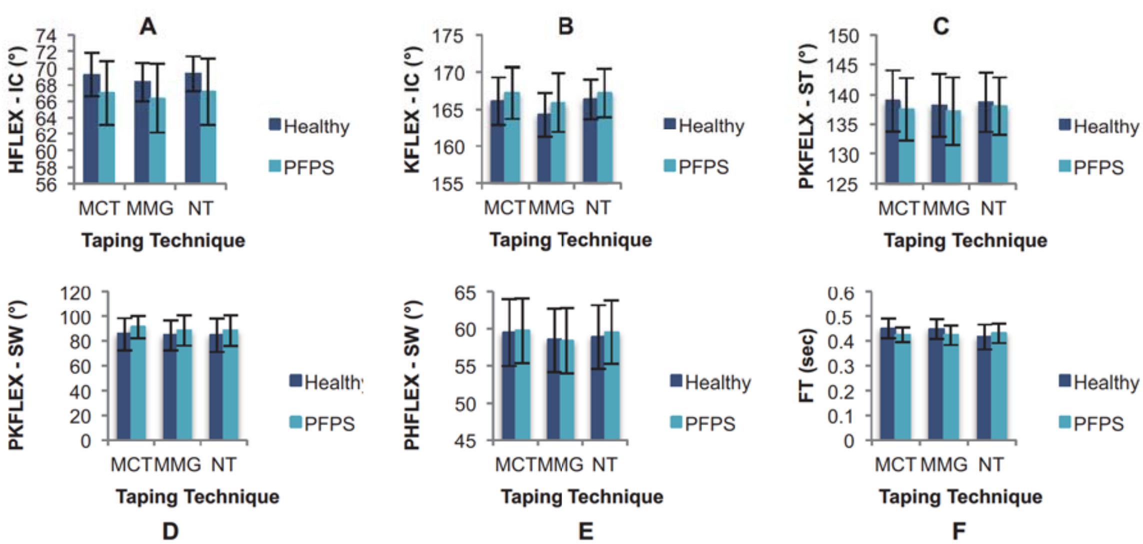


**Figure 1:** Mean angular displacements throughout the running gait cycle, and flight time in runners with and without PFPS. Error bars denote standard deviation around the mean.

When looking at the effects of therapeutic taping on time, mixed results were seen. While taping did not significantly affect contact time, it did significantly affect flight time ($F$ (2, 60)=5.016, $p$=.01). This was evident between the MMG (M=0.438s, SD=.04) and NT (M=0.443s, SD=.04) conditions ($p$=.012). This may be explained by what occurred throughout swing, where MMG resulted in increased hip and knee flexion angles, allowing the shank to be closer to the body, ultimately allowing the body to be more quickly propelled forward through the air. There was no significant difference, however, between the MCT and MMG, or the MCT and NT condition.
Furthermore, no significant interaction effects were found. Therefore, the effect of therapeutic taping was not conditional upon the group/condition of the participants. Since this study is the first to investigate the effects of therapeutic taping on lower extremity kinematics in those with and without PFPS during running, further research is required to clarify the proposed mechanisms, as well as conclusively identify the effects of therapeutic taping during running.

**CONCLUSION:** Based on the results of this study, it is suggested that the application of tape may affect running mechanics more than no tape. Furthermore, MMG with Leukotape allowed for more flexion at initial contact, which may allow for greater activation of the quadriceps and gluteal muscles, as well as greater force absorption, possibly decreasing the amount of stress placed on the PFJ in runners with PFPS. MMG also resulted in shorter flight times, which may increase overall running efficiency. While this study has provided preliminary evidence regarding the impact of patellar taping techniques on lower extremity kinematics during running, additional research is needed to determine the exact clinical utility and effectiveness on pain. This study begins to bridge the gap in the scientific literature, while simultaneously contributing to the advancement of sports and exercise and rehabilitation. It may cause health care practitioners and runners to reflect on the decision to use patellar taping techniques during running.

**REFERENCES:**

Ferber, R., & Macdonald, S. (2014). *Running mechanics and gait analysis*. Champaign, IL: Human Kinetics.

Callaghan, M. J., & Selfe, J. (2012). Patellar taping for patellofemoral pain syndrome in adults (Review). *Cochrane Database of Systamatic Reviews,* (4), 1-39. doi:10.1002/14651858.CD006717.pub2

Jackson, K. M. (1979). Fitting of mathematical functions to biomechanical data. *IEEE Transactions on Biomedical Engineering, 26*, 122-124. doi:10.1109/TBME.1979.326551

Kase, K., Wallis, J., & Kase, T. (2013). *Clinical therapeutic applications of the Kinesio taping method* (3rd ed.). Albuquerque, NM: Kinesio Taping Association International.

McConnell, J. (1986). The management of chondromalacia patellae: A long term solution. *The Australian Journal of Physiotherapy*, *32*, 215-223. Retrieved from http://www.physiotherapy.asn.au/jop

Powers, C. M., Landel, R., Sosnick, T., Kirby, J., Mengel, K., Cheney, A., & Perry, J. (1997). The effects of patellar taping on stride characteristics and joint motion in subjects with patellofemoral pain. *Journal of Orthopaedic & Sports Physical Therapy, 26*, 286 – 291. Retrieved from www.jospt.org

Richards, J. (2008). *Biomechanics in clinic and research*. Philadelphia, PA: Churchill Livingstone Elsevier.

Salsich, G. B., Brechter, J. H., Farwell, D., Powers, C. M. (2002). The effects of patellar taping on knee kinetics, kinematics, and vastus lateralis muscle activity during stair ambulation in indivdiuals with patellofemoral pain. *Journal of Orthopaedic & Sports Physical Therapy, 32*, 3 – 10. Retrieved from www.jospt.org